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How Machine Castings Are Made

Extensive Mechanical Equipment Has Made It Possible to Produce Castings Conforming to the Severe Specifications of This Class of Work With Unskilled Labor

THE Modern Foundry Co., which operates a large establishment in Oakley, a suburb of Cincinnati, is all that the term implies. It represents the best modern practice in that it has designed, built and equipped a plant to operate to a large extent mechanically, and with a minimum of skilled labor. The multiplicity of features involved in making molds and cores which under ordinary conditions require skill and training on the part of the workmen have been divided into a number of groups and unskilled labor has been trained in a short time to perform the simplified duties. Furthermore, if one workman or a group leaves the company's employ, it does not seriously hamper production. There is no waiting to secure the services of highly skilled men to replace them nor is it necessary to train green men to a point where their services are valuable. In justice to the company, it should be pointed out that this latter feature is only a secondary consideration. The policy of the company as exemplified and carried out by W. M. Kelly, the general superintendent, insures to every man a square deal, ample compensation according to his efforts, and pleasant, congenial surroundings. This has resulted in a low labor turn-over. Following the general plan of system and standardization the molds are classified according to size and each group

FIG. 1—THE FLASKS ARE SET ON SPECIAL PLATES TO WHICH THE PATTERNS ARE ATTACHED FIG. 2—SEVERAL FLASKS ARE PLACED ON THE TABLE OF THE JOLT RAM MACHINE AT ONE TIME FIG. 3—AFTER THE MOLDS ARE TAKEN FROM THE MACHINE THEY ARE SET ON THE FLOOR, FINISHED, BLACKED AND MADE READY FOR THE OVEN

FIG. 4—THE SAND IS SHAKEN OUT IN THIS BAY, RECONDITIONED AND LOADED IN THE STANDARD RAILROAD CAR WHICH OPERATES ON A SHORT LENGTH OF TRACK ACROSS THE ENDS OF THE TWO ADJOINING BAYS—THE EMPTY FLASKS ARE RETURNED TO THE MOLDING FLOOR BY THE SAME CAR

is segregated and handled as a unit. For this purpose the foundry is divided into several bays adjacent to each other and approximately 40 x 200 feet.

Taking them in the order in which they come, the first two bays are used exclusively for the production of molds which can be made in snap flasks. These are molded on squeezer machines supplied by the Osborn Mfg. Co., Cleveland. The next bay is equipped with two power jolt-ram, roll-over, pattern-draw machines. One of these is placed at each end of a common track which extends across the front of a number of floors which are spanned by air operated traveling cranes. This bay is devoted principally to the production of cone pulleys and other castings of a like character which require the services of deep drawing pattern devices. The molds are made on the machines at each end of the track. Each machine is served by a low truck which receives the mold after it has been rolled over. The truck is then pushed along a track until it is directly in front of the floor designated for this class of work. Here the mold is picked up by a light 2-ton crane, one of which operates over each floor, and set down in its appointed place. These cranes also are used to pour the iron, shake out and pile the flasks and load the castings on the electric trucks which form an important part of the shop equipment.

The fourth bay is given over to the production of dry sand molds. The cupolas are located at one end of this bay and a transfer track for handling the sand at the other; but all the remainder of the floor area is devoted to the different operations necessary in the production of castings by the dry sand method.

Castings Are Symmetrical

The castings for machine tools, to a considerable extent are symmetrical and it is necessary to part the patterns in the center longitudinally and make one-half in the drag and the other half in the cope. In the Modern foundry each half pattern is mounted on an individual plate which has been planed perfectly true and is provided with center and guide lines to assist in locating the patterns. The holes for the pins on these plates which are employed for locating the flasks are situated on the main center line and were drilled through the same jig that was employed in locating the pin holes in the flasks.

The molding operations are started near one end of this bay. A number of pattern plates on which patterns are mounted, are set on the floor. The flasks, provided with bars in the cope and drag and having planed joints then are lowered onto the respective parts. The gate pins, rods, gaggers or vent pipes having been set the flask is filled with sand from a grab bucket suspended from one of the three Pawling & Harnischfeger Co., cranes which operate in this bay. All of the molds are rammed on a plain jolt-ram machine having a table 6 x 8 feet. As fast as the flasks are filled they are taken over and placed on the ramming machine two or three at a time. Having been jolted the required number of times, the top is rammed with the butt of a pneumatic rammer, after which the excess sand is scraped off. The molds then are lifted, turned over and set down on the next floor where they receive the necessary finishing at the hands of a few skilled molders. From there they are taken to the ovens and next day are removed, cored

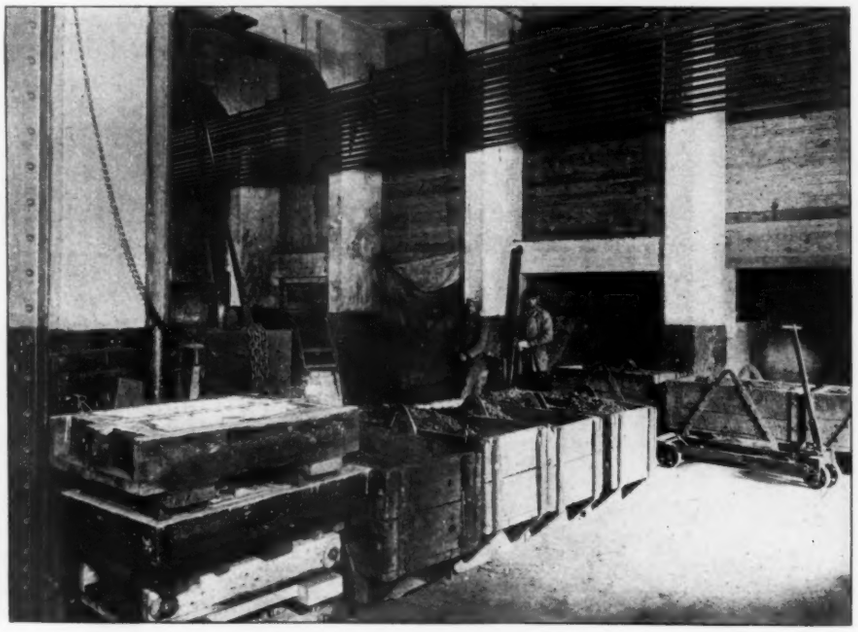


FIG. 5—THE SAND IS STORED IN THE BINS SHOWN IN THE BACKGROUND. IT IS LOADED IN THE BOXES BY HAND AND CONVEYED TO ANY PART OF THE FOUNDRY BY LIFT TRUCKS OR BY CRANES

and closed by workmen who do nothing else and therefore have developed a speed and accuracy in this work.

The sequence of operations described has brought the molds to the opposite end of the bay and in close proximity to the cupolas where they are poured. Shortly after the molds are poured, they are carried into an adjoining bay which is separated from the others by a brick wall extending from the floor to the ceiling on both sides. This bay is not so wide as the others. It is used as a shake-out floor, for the dry sand molds, and in addition to helping keep the sand confined while it is being screened, tempered and reconditioned, one section of the bay is occupied by

FIG. 6—THE CORES ARE TURNED OUT ON HEAVILY RIBBED PLATES WHICH ARE BUILT UP THREE OR FOUR TIERS DEEP ON THE SUBSTANTIAL CORE CARRIERS SHOWN—LIFT TRUCKS ARE EMPLOYED TO CONVEY THESE LOADS OF CORES INTO THE OVENS FIG. 7—AFTER THE CORES ARE DRIED THEY ARE TAKEN OFF BY THE CRANES AND LOADED ON WOODEN PLATFORMS—THE ELECTRIC TRUCKS PICK UP THE PLATFORM WITH ITS LOAD OF CORES AND CARRIES IT WHEREVER IT IS NEEDED

the four drying ovens. The fire box for these ovens is situated at one end of the battery and the heat from the coke fire is drawn through a long brick chamber extending across the front of the ovens below the floor level. Damper plates are provided in the passage leading to each oven so that it is feasible to heat one or more single ovens or the whole battery at one time. The gas exhaust openings from each oven are situated in the side walls near the floor and are connected to a long flue which extends along the back of the ovens and terminates in a suction fan which delivers the gas to the smoke stack. Each of the individual openings leading to the main flue also is provided with a damper plate so that it is relatively easy to maintain an even temperature. Recording pyrometers, one at the back of each oven, serve as a guide and check for the man doing the firing.

The sand from all the dry sand molds is shaken out in one pile and the flasks are piled alongside the walls in this bay. A huge permanent A-shaped screen is set up near the sand pile and all the sand which is fit to use again is passed through this screen by the simple expedient of lifting it in a grab bucket and letting it fall over the apex of the screen. The lumps of hard sand, gaggers, scrap, etc., all roll to the bottom on the outside and are taken away at regular intervals. The riddled sand between the wings of the screen is collected by the grab bucket when a sufficient quantity has accumulated and loaded into a standard railway gondola car on a short section of track across the ends of the bay in which the sand is mixed and the bay in which the sand is filled into the flasks. When the car has been filled with sand, a load of empty flasks is placed on top and also sent into the molding bay. A long cable attached to the car at each end and running through sheaves anchored to *dead men* in the floor is used for pulling the gondola back and forth by attaching a loop in the end of the cable to the hook of the crane.

A 6-foot muller-type pan made by the National Engineering Co., Chicago, is situated close to the screen and discharges facing sand through a doorway in the wall separating the sand mixing bay from that in which the molding takes place. This is shown at the left in the back ground, Fig. 1. The facing sand accumulates in a pocket below the floor level where it can be reached by a grab bucket suspended from the crane. An ingenious device attached to the grab buckets operating at various points in the Modern foundry is an independent control for regulating the opening and closing of the two jaws of the bucket. With this device it is possible to deposit part of the contents in several flasks. The bucket can be opened to its full extent and the entire contents dumped as in ordinary practice, or it may be opened part way, a small quantity allowed to trickle out and then closed and the remainder of the load dumped elsewhere.

The sixth and last remaining bay is the same length as the others but somewhat wider. It is equipped with three jar-ram, roll-over, pattern-draw machines made by the Osborn Mfg. Co., Cleveland. Each machine is a different size and capacity and the work is arranged so that the flasks most suitable to each machine are piled near it. The largest machine takes flasks up to 6 feet in length; the next size accommodates flasks up to 5 feet; and the smallest machine will handle anything up to 4 feet long. The machines are spaced at equal distances along one side of the bay and the molds, as fast as they are made, are taken away and set down in rows by three Pawling & Harnischfeger 5-ton cranes. The patterns used in this bay all are mounted on pattern plates or boards in a manner similar to those already mentioned when commenting on the equipment employed in the bay where the dry sand molds are made.

Since dry sand cores enter so extensively into the molding of boring mills, milling machines, radial drills

and other machine tools, it is only natural to find that the core department in the Modern foundry occupies a large space.

Views taken from three points in the coreroom are shown in Figs. 5, 6 and 7. A smooth concrete floor facilitates the use of an automatic lift truck which is used for carrying the cores from the point where they are piled after being taken off the core carriages, to the molds in the different parts of the foundry. Considering the core making process in the regular sequence of operations, the first item of interest is the row of sand storage bins partly shown in Fig. 5. These extend across the entire width of the building. A wide and roomy gangway separates the sand bins from two sand mixing machines; one a rotary paddle type made by the Blystone Mfg. Co., Cambridge Springs, Pa., used principally for making oil sand mixtures; and the other a 6-foot pan of the muller type supplied by the National Engineering Co., Chicago. Various standard mixtures are made in the latter. Sand is cheap and plentiful in the vicinity of Cincinnati and advantage is taken of that fact to use a maximum of loam sand in the mixture and a minimum of artificial dry binder.

After the core sand has been mixed it is taken, in the boxes shown in Fig. 5, to the three Osborn jar-ram, roll-over, pattern-draw machines. These boxes are handled by the truck as may be seen by referring to Fig. 5, or they may be transported by the crane. When the crane is employed, chain hooks are attached to the eyes in the triangular iron braces bolted to the sides of the boxes.

Standard core making methods are observed in setting arbors, rods, hooks and in making vent passages, but no cores are hand rammed, and none turned out on crooked or warped core plates. As already stated, three machines are used for making all of the larger cores. One of these machines is located at the end of the bay shown in Fig. 7. The other two, which are smaller, are situated in the side bay to the right.

The cast-iron core plates are heavily ribbed on the back to insure rigidity and the face which comes in contact with the core in all cases is planed absolutely true. The plates are provided on the back with two staples for convenience in handling when putting them on the coreboxes. After the cores are rammed and turned out on the plates they are blacked and loaded on the stands, in the manner indicated in Fig. 6. The stands are stiff rectangular frames resting upon two parallel supports. As soon as a stand is loaded one of the lift trucks is slipped in under it and it is conveyed to the oven and set on the floor. Four ovens, 6 x 6 x 10 feet, fired with natural gas are employed for drying the cores. A small blower made by the Connersville Blower Co., Connersville, Ind., driven by a 10-horsepower Allis-Chalmers motor is used to exhaust the waste gas and create a circulation of heat in the ovens. The same fan performs a like service for the ovens upstairs in the girls' coreroom; which will be described later.

After the cores are dried the rig shown suspended from the crane in Fig. 7, is employed to lift them off the cars. This device consists of two pairs of cam hooks attached to a pair of sling chains. The hooks are made of 3 x ¾-inch flat bar iron. The toes at the lower ends are bent to engage the plates. Slightly higher on the shank they are bent at an obtuse angle to prevent them from pulling in and jamming the core when the core and plate are suspended from the crane. A small gas fired drawer-type oven situated near the large ovens is used for drying the round stock cores which are made on a Wadsworth core machine mounted on a bench nearby. This oven also is employed to dry the hand ladles used by the men engaged in snap work. These hand ladles are provided with a self skimming device consisting of a partial hood across the top of the ladle with a hole through it which allows the metal to pass.

All of the small cores with the exception of the stock cores already mentioned are made in a specially equipped coreroom situated over the sand bins. This second-story coreroom is served by an elevator which carries sand and other supplies up, and racks and boxes full of cores down. This coreroom is a complete,

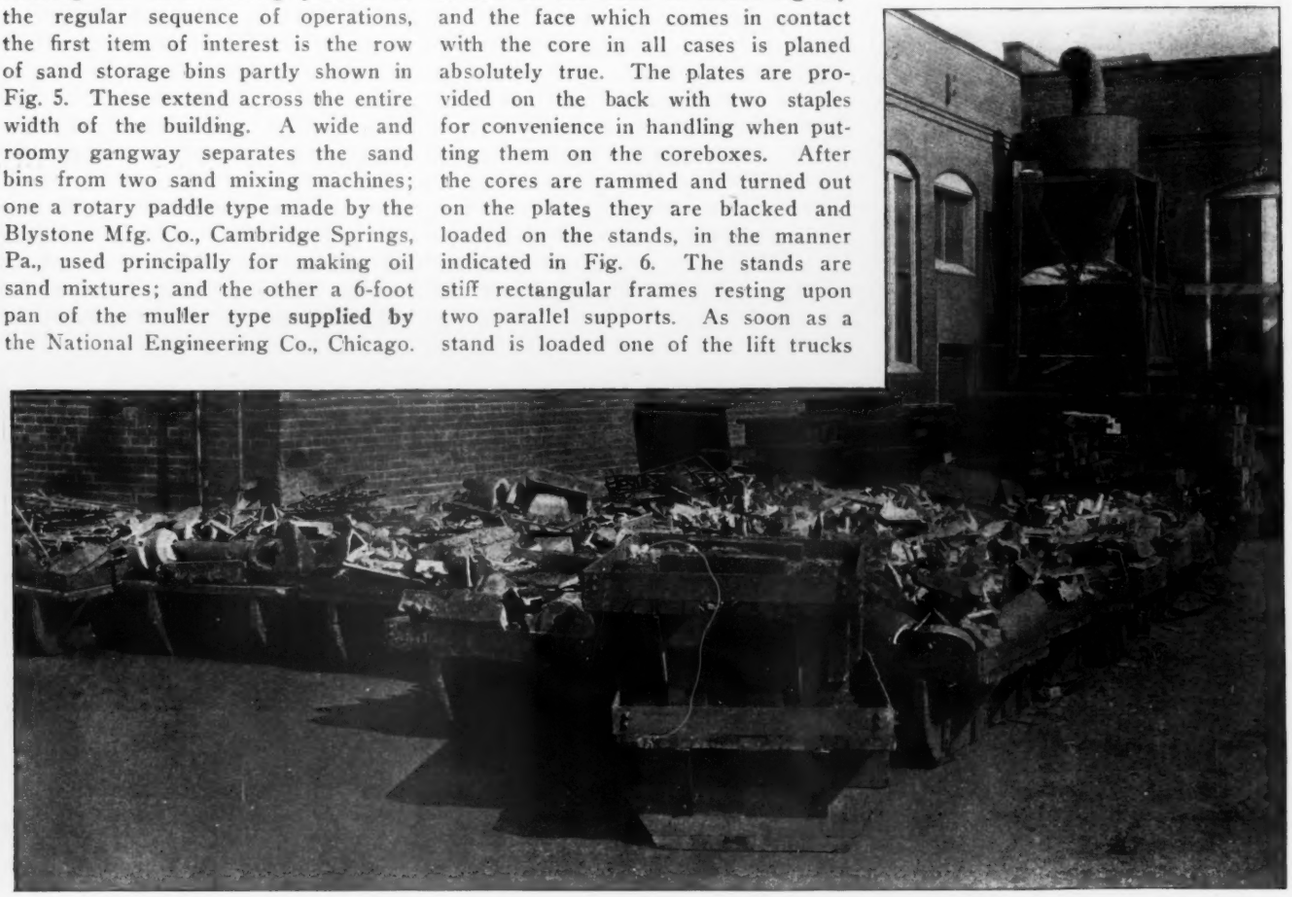


FIG. 8—THE IRON CHARGES FOR THE CUPOLA ARE MADE UP ON WOOD PLATFORMS REINFORCED BY AN IRON BAND AROUND THE TOP AND SEVERAL IRON BRACES AT THE ENDS AND SIDES—THEY ARE CARRIED TO THE CUPOLA ELEVATOR BY AN ELECTRIC TRUCK WHICH HAS A SCALE INCORPORATED IN THE LIFTING PLATFORM

self-contained unit and is "manned" entirely by women. None of the work is heavy and to make the conditions still more agreeable, and lighten the physical exertion, the superintendent recently substituted aluminum core plates for the cast iron plates formerly in use. The core benches are situated closely around the wall while the core ovens of the gas-fired drawer-type are in the center of the floor. There is ample heat, light and ventilation.

Preparations now are under way for greatly increased tonnage. To assist in this, the company will install a large jolt-ram, roll-over, pattern-draw molding machine made by the Osborn Mfg. Co., Cleveland, capable of handling molds weighing up to six tons. A new cupola made by the Whiting Foundry Equipment Co., Harvey, Ill., also will be added. The cupola design has been changed considerably and several interesting features added at the instigation of the superintendent who also has designed and installed an elevator system to facilitate charging the new cupola.

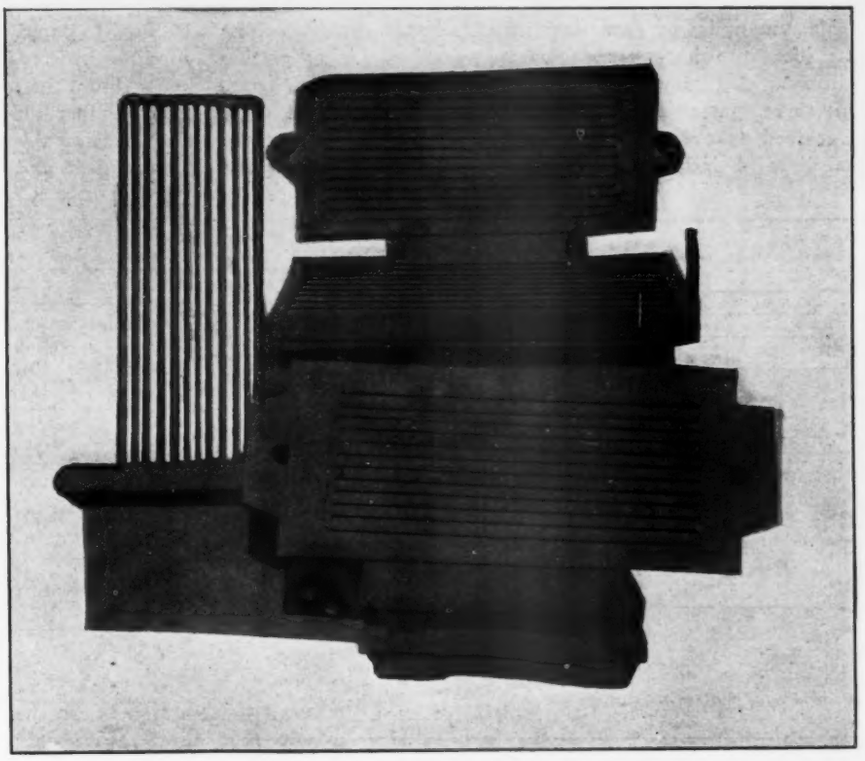
The daily heat at present ranges between 80 and 90 tons and this is taken care of by a Whiting cupola lined to 60 inches. The blast is furnished by a positive pressure blower made by the Connersville Blower Co., Connersville, Ind., and capable of delivering 40 cubic feet of air per revolution. It is driven at a speed of 200 revolutions a minute by a 40-horsepower Allis-Chalmers motor. This results in the delivery of about 500,000 cubic feet of air an hour. The iron is melted at the rate of 15 tons an hour. The composition of the charges vary occasionally but an average 4000 pound charge consists of 1800 pounds of pig iron and 2200 pounds of scrap. Steel scrap is used in amounts varying from 5 to 20 per cent.

Wooden platforms like those shown in Fig. 8, are used to handle iron. They are placed in the stock yard near the piles of iron and loaded. An electric truck made by the Automatic Transportation Co., Buffalo, N. Y., and having a scale table is employed to lift and carry these platform boxes to the cupola elevator. When the elevator reaches the charging platform another truck is employed to carry the loaded frames to a favorable charging position near the cupola. Coke is loaded in cans which hold 70 pounds each and the contents of five cans is spread between the successive iron charges.

How to Make Cast Iron Welding Rods

NEARLY all gray-iron foundries which weld their castings purchase the welding rods instead of casting them. Two requirements stand in the way of the foundry man who wishes to make his own welding rods. The one is the high expense of adequate equipment compared to the limited demand for the product by a single foundry. The other is that an iron is required which is higher in silicon than the general run of metal poured by the foundry. The silicon should be above 2.50 per cent, but otherwise the composition of metal may be the same as is used by the average foundry. The Gale Manufacturing Co., Albion, Mich., which manufactures welding rods for the trade and makes them of a metal having 2.60 to 2.80 per cent silicon, 0.09 to 0.10 per cent sulphur, 0.50 to 0.55 per cent phosphorus and 0.45 to 0.50 per cent manganese. This iron has proved satisfactory and does not cause hard spots in the castings. A large number of rods are produced by one molder with the aid of a pattern mounted on an aluminum plate. The pattern is made of brass rods split in two and riveted to the plate. The gate is located on the end and twelve rods are run from it, as shown in the accompanying illustration. The job is made on a squeezer machine with an ordinary snap flask and a stiff squeezer board. Experience has shown that a stiff board is necessary to take care of the strain through the center unless the plate is made unduly heavy. A medium fine sand is riddled on the pattern through a ¼-inch riddle. The molds are tilted for pouring by raising the gate end about 2 inches off the floor. The molders are taught to be careful not to force the iron into the mold too fast when pouring.

Sand on the rod will cause trouble in welding, so care is taken to see that the rods are well cleaned before shipment. Rods up to ⅜-inch in diameter are sandblasted, while rods ½ or ¾-inch in diameter are cleaned in a tumbling barrel. In the former case the rods are fed by an ingenious device into an automatic sand blast cabinet where the scale and sand are removed. In the latter the rods are packed closely in a small tumbling barrel from which they emerge perfectly clean and shining. They are then graded for size and stocked for shipment.



MANY RODS CAN BE PRODUCED IN A DAY FROM A PATTERN MOUNTED ON AN ALUMINUM BOARD, OPERATED ON A SQUEEZER MACHINE

Cultivate Idea Men In Foundries

Changes and Improvements in Manufacturing Methods are Directly Traceable to Ideas Born and Brought to a Successful Issue by the Originator or Through the Co-operation of Others.

BY R. R. CLARKE

IDEAS are revolutionary forces. They mark sharp turning points in human experience and divide new from old orders. Every step of material progress was first conceived as an abstract idea which slowly crystallized in some master mind to be later brought to light and applied. Genius, invention, progress are synonymous terms for the application of ideas. Where does your business stand today, how fast, how cheaply, how efficiently can you produce? Look it over carefully and see if you don't stand exactly where the brains of your organization put you, with ideas expressed in such items as mechanical appliances and devices, pouring off systems, relative location of melting room and coreroom to molding floors, of molding floor to cleaning room, cleaning room to shipping room, and thousands of points of design. Ideas expressed further in molding machine equipment, gated-up patterns, mounted plates and all other instances where ordinary methods have been discarded for quicker and simpler systems.

The task of the idea man is to think and scheme the idea into harmony with the conditions. By way of illustration: From three patterns furnished, a foundry received an order for 100 circular brass disks, 4 inches in diameter, 1 inch thick and containing two short side lugs diametrically opposite each other. The customer pleaded for quick, cheap work. Two alternative methods are open, make three additional patterns to fill a flask or get the best results with the three patterns furnished. The idea man would tack the three patterns on a board close to one end and gate them up in such manner that he could ram or squeeze 17 drags on a molding machine, then squeeze, up 17 copes, from the same board, reverse his copes from the drag impressions when setting them on the drag. He thus would get three castings in the drag and three in the cope of the mold, or six castings from the three patterns furnished.

Criticism is Valuable

The idea man must possess originality and be broad-minded and open to suggestions and criticism. He gets an idea, it is his own and to him a seemingly perfect conception. Now if he will submit that idea to someone of unbiased good judgment and practical insight, he might go a long way toward perfection. After getting his idea well under way, if his superior official or some workman of lower rank points out some detail that could be improved, he will take the advice seriously and analyze it carefully instead of passively resenting it. Usually, the idea man is of greater value on general features than on details. He is better on conceptions then on the mechanical particulars of applying his ideas. He has others such as pattern shop foreman and machine shop foreman, to consummate his plans. It is quite obvious that to make the most of opportunity he must recognize the great value of the co-operation of these men of practical experience. In the writer's shop, we attempted to mount air port patterns a couple of years ago for machine molding and found the proposition a little puzzling due to the pattern peculiarities. We conceived a plan involving metal patterns and went over it with the machine shop superintendent, a man of decided ability. The patterns adopted include the principles of the original conception throughout, but they embody also changes in details of most pronounced value furnished by the machine-shop man.

One must keep himself well posted on up-to-date methods, and be willing to apply them to his own conditions. It is a good thing to know how the other fellow does it. After finding the other fellow's conditions identical, take his idea, improve on it and adapt it to suit the

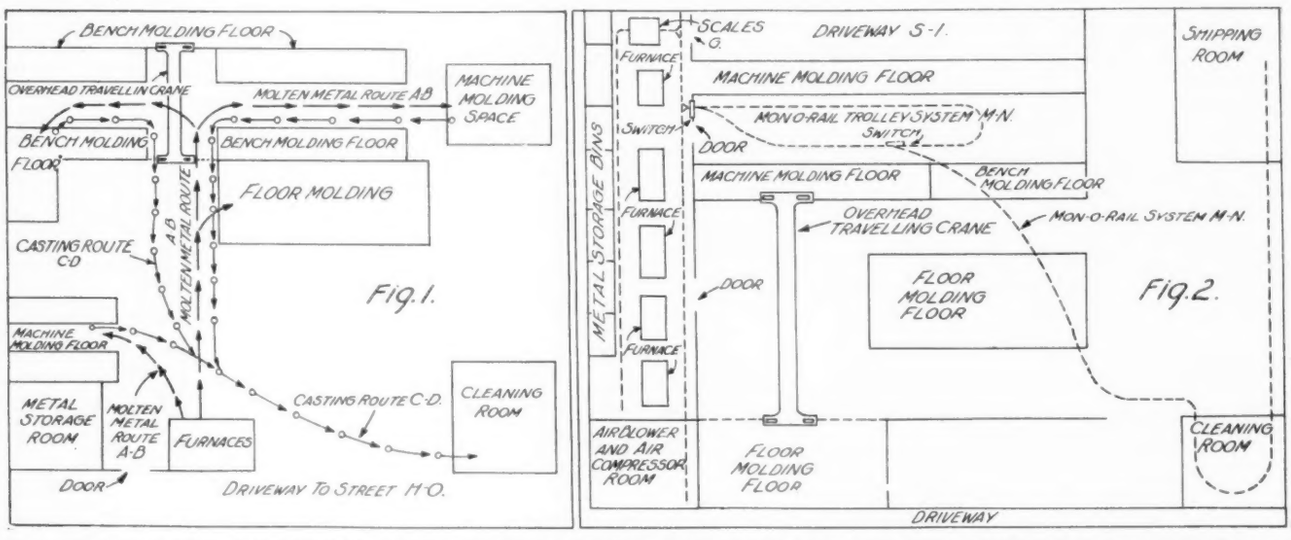


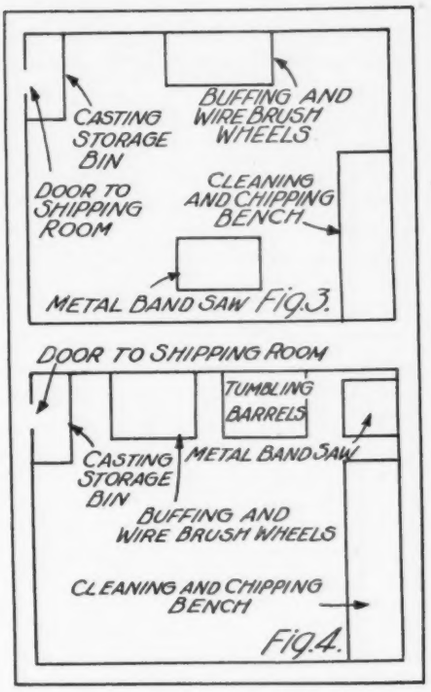
FIG. 1—GENERAL LAYOUT OF THE FOUNDRY SHOWING THE INVOLVED ROUTE TAKEN BY THE METAL FROM THE STORAGE BINS TO THE SHIPPING ROOM
FIG. 2—BY A JUDICIOUS REARRANGEMENT THE WORK HAS BEEN GREATLY LIGHTENED PARTICULARLY IN HANDLING THE METAL BEFORE AND AFTER IT HAS BEEN MELTED

circumstances. An idea man must keep in touch with methods and progress along industrial lines in general. It's a long way, comparatively speaking, from a barn to a foundry, yet many modern barns are equipped with light, commodious, monorail trolley systems that could be used to maximum advantage in a foundry. The parts of this system consist of rails, hangers, trolleys and switches capable of sustaining a 1000-pound load. They are manufactured and sold at a reasonable cost and would fit many foundry conditions perfectly. For instance in transporting and pouring off metal within their capacity there is nothing handier, cheaper or more efficient.

The idea man must carry a full stock of self-reliance and initiative. He must have self-confidence and be able and determined to go ahead unaffected by resistance. For some undefined reason the way of the progressive man always has been hard. The world ridiculed Columbus, laughed at Fulton and called Bessemer crazy. Under adverse conditions the only course is to hold fast to your convictions, keep your head level, your mouth shut and go ahead.

Impractical Methods Expensive

The idea man must be practical. Practicability is the great test and without it no idea, however perfect it may be theoretically, is worth the breath used in expounding it. The true idea man will carefully go over every detail of application and operation and satisfy his mind that the abstract conception will in its concrete and working form be practicable, simple and efficient. Occasional miscalculation is inevitable and excusable in all men, but persistency in clinging to a losing practice regardless of its



FIGS. 3 AND 4—CLEANING ROOM LAYOUT AS FOUND AND ALTERED

limitations, from a mere sense of vanity, can find no justification under ordinary circumstances.

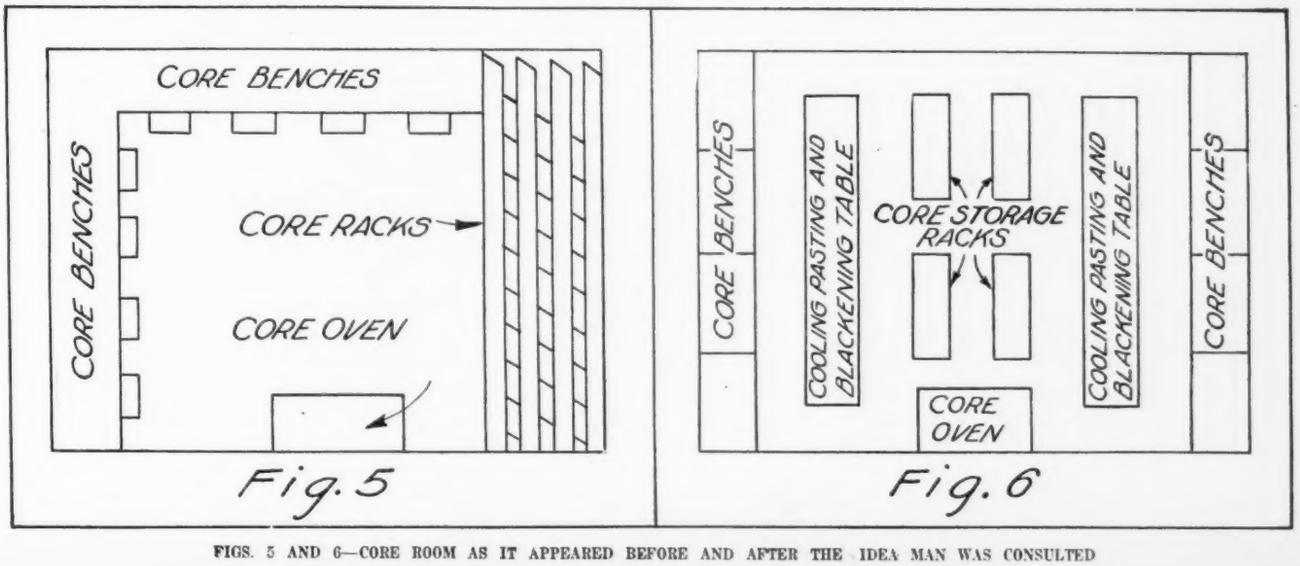
To increase and cheapen output a foundry foreman discarded the method of molding driving box shells on the flat side in favor of casting them on end. In the latter method he combined two patterns in one, using dry sand cores at first and later iron chills to separate the castings. The idea looked good to him on paper but actual practice disclosed its fallacy. He had to use a three-parted flask and make two partings. The ramming became much more particular and slow. Lifting the heavy cheek off the drag and later setting it back was drudgery requiring four men for each lift. Dressing and facing the mold was a serious handicap, and setting the additional cores consumed extra time and patience. The method was a decided failure, yet the foreman refused to abandon it and accused his molders of laying down on the job. Being a piece-work shop the men refused to make driving box shells and one by one started to quit. The situation soon became acute and forced a return to the original method.

The idea man figures closely on cost and profit. The question "Will it pay" to him is of vast significance. If an order for 1000 castings will scarcely pay for plate-mounting the patterns, he will not consider the idea; but if an order for 10,000 will pay, he will accord the plate mounting feature serious consideration. The promise of duplication, the time and output gained as compared to the initial expense, always will vitally affect plans and calculations.

Specialists Are Needed

The question might arise "When does an idea pay?" Naturally when increased output at reduced cost continues long enough to offset initial expense and yield substantial profit. If it is an even break, it is apparently useless to bother with making the change. However, suppose the change makes a task easier or gets a job out quicker or relieves congestion in another hard pressed quarter, will it pay even though no monetary saving is involved? Sometimes it may not, though often doubtless it will. The true idea man applies sound and analytic judgment to such a problem.

The best idea men are specialists. Sometimes all-around idea men fit well into those smaller concerns unable



FIGS. 5 AND 6—CORE ROOM AS IT APPEARED BEFORE AND AFTER THE IDEA MAN WAS CONSULTED

to place one in each separate department, but large concerns will find it pays to specialize. As business reaches the magnitude where the capacity of the coreroom, the cleaning room, the general foundry layout, and the molding floors, is severely taxed, brainy talent in or at the head of each department undoubtedly will yield greater results than any number of all around men.

Changing the Layout

General foundry layout embodying relative position or location of different departments is a big item. An actual case will illustrate the point. On assuming his new duties a foundry superintendent found the layout as illustrated in Fig. 1. He at once noted the illogical position of the furnaces and metal storage room and recommended a change. It will be noticed that raw material was delivered to metal storage room over driveway *HO*. From the storage room it was wheeled back to the furnaces past which it originally was hauled. From the furnaces it was packed by hand over routes *AB* to the different molding floors where it was picked up by a trolley crane and poured. Over the bench-molding floors a heavy overhead, hand-operated, traveling crane moved ponderously up and down the shop and had a light but by no means convenient transverse carriage. To pour up and down the shop on light and mixed bench work was utterly impractical due to the inertia of the crane in starting and its momentum in stopping. Further, to arrange the molds transversely allowed little pouring freedom, beside necessitating stepping over the molds. After the castings were poured and shaken out they were brought back past the furnaces to the cleaning room by wheelbarrow and over routes *CD*.

The superintendent contended that raw metal should enter the shop at one end and by straight forward movement pass through the shop in its different forms until emerging in finished product at the opposite end. After considerable opposition and argument his plan was adopted as shown in Fig. 2. An addition was built at the rear of the foundry and a battery of five air and oil furnaces placed in the position indicated. Back of the furnaces and within charging distance, metal storage bins were placed. Raw material is delivered by auto truck over driveway *SI* to door *G* and there picked up by a monorail trolley, carried over the scales where it is weighed and thence to the metal storage bins.

The growth and perfecting of machine molding in this shop eliminated most of the bench molding floors which now are used for machine molding, abolishing the machine molding floor in the rear corner of the shop as shown in Fig. 1. This brought all light and medium weight flasks under the same trolley system. This trolley system is a monorail running from the molding floor back to the furnaces and continuing from the molding floors across the shop to the cleaning room where it makes a loop and stretches onward to the shipping room.

Raw material enters door *G* and over driveway *SI*. It is picked up by

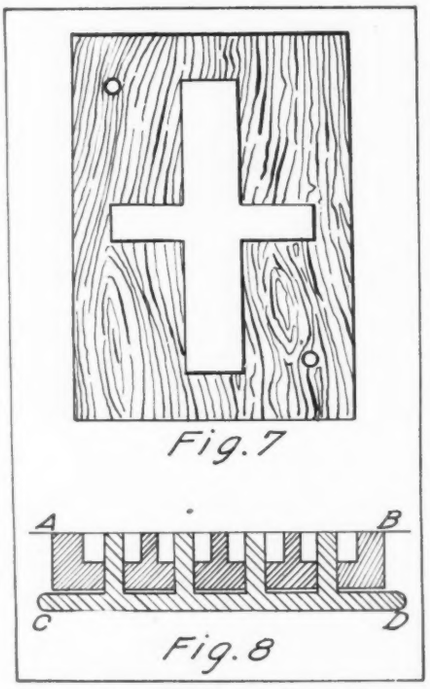


FIG. 7—HALF SECTION OF CORE BOX FOR TROLLEY WHEELS AS IT CAME FROM THE CUSTOMER FIG. 8—SECTION OF GANG CORE BOX FOR MAKING THE DISK CORE FOR THE CHAMBER IN THE TROLEY WHEEL

trolley and set on the scale, weighed and transported direct to the storage bins back of the furnaces. From the furnaces the metal is caught in a pouring ladle hanging on the trolley and transported directly to the molding floors. Castings shaken out are picked up on a specially devised carriage which is suspended from the trolley and taken directly to the cleaning room where, after being cleaned and ground, they are picked up by the same carriage and taken directly to the shipping room. Gates accumulating in the cleaning room are thrown into an iron box which is picked up by trolley and sent back to the furnaces daily over the same trolley system. The actual benefits of this new system are so vast and pronounced as to admit of no comparison.

The change was not all due to one man's idea. The superintendent conceived the idea of general change and was responsible for the monorail system from the furnaces to the molding floors. The general manager carried the system from the molding floors to the cleaning room; the shipping clerk conceived the plan of going onward to the shipping room; while the machine shop superintendent suggested the idea of unloading raw material in addition to furnishing ideas on detail throughout.

Further Examples

Another example illustrates the value of co-operation. A cleaning-room foreman in a small foundry inherited the layout shown in Fig. 3. Castings on gates were brought to the cleaning bench, hand-brushed and delivered to the saw 10 feet to the right. Following sawing they were carried to buffing wheels and wire brush wheel 15 feet forward, and thence carried quite a distance to shipping room. Under the changed arrangement shown in Fig. 4, castings are delivered to the cleaning bench, pass to the tumbling barrels, thence to the buffing wheels and on to shipping room. The difference is too apparent to require comment.

Compare the coreroom shown in Fig. 5 with that in Fig. 6. The one indicates constructive indifference as actually found, the other representing changes resulting from ideas springing from thoughtful planning. In Fig. 5, eight coremakers worked from 10 to 30 feet from the core oven and from 5 to 25 feet from the core storage racks. They made, pasted and blackened their cores on the same bench. Fig. 6 shows the rearrangement and includes spacious tables for shifting, cooling, pasting and blackening the cores. These tables with their under bins and drawers and with the more advantageous location of stable core storage racks, represent a handiness and efficiency a hundred fold greater than the original.

The arrangement and construction of core boxes conducive to speeding up the output represents another core-room possibility. A single example follows. Fig. 7 shows a cross section of a split core box for trolley wheels as delivered by the customer. Castings were ordered in 300, 500 and up to 1500 lots. A gang or multiple core box was made to make six straight, round cores corresponding to

the axis core in Fig. 7 at one time. In Fig. 9, parts *AB CD* are separate, *AB* is a flat plate with four flat bottom holes drilled partly through it and the same size as the disk part of the core in Fig. 7. Extending through the plate and center of each hole, a smaller hole is drilled. This hole is a shade larger than the diameter of the axis core of Fig. 7. The portion, *CD*, is a flat metal plate with four parts sticking up, these parts being the diameter of the axis core and of such a height that they come flush with the top surface of *AB*, when the two parts are placed together. The disk cores are made rapidly in this composite box by ramming, rolling over, lifting *CD* off *AB* and finally drawing *AB*. At similar speed the axis cores are made separately. Both axis and disk cores then are dried after which the disk core is pasted onto the axis core at its center. The pasting is done by setting the axis core upright in a measuring form—a mere wooden block with a hole in it—dropping a little paste in the crevice between the two cores, turning the block sideways, drawing the core out and laying it on a drying rack. Arguments advanced against the method were that the core would blow because of the absence of a vent from the disk to the axis and that the bond of paste would break and permit the disk core to shift under the buoyancy of the metal. Out of hundreds of castings made, there was not a single such calamity.

Special Equipment Pays

Every foundry tool, device or appliance, every peculiarity of condition admits a possibility of novelty and improvement. In a railroad shop locomotive rod brasses had been made by ramming first the cope of a level-parting flask, rolling over, ramming the drag, rolling back and finishing. The foreman hit on the idea of a flask that would part with the journal-line of the rod brass and adopted it. This change in flask decreased the cost and increased the output of rod brasses over 25 per cent. The sides and ends of these flasks were cast separately and later assembled by bolting them firmly together. In a manufacturing plant using snap flasks, the practice always had been to nail strips of wood on the top of the cope or bottom of the drag to increase the height or depth. Patterns were made to make metal half frames, 1 and 2 inches high for the three different sized flasks in use. These half frames were cast of aluminum and uniformly drilled for screw holes after which the iron strips on the flask were drilled similarly. The aluminum frames outlasted many wooden strips, always gave a smooth, level, top and bottom surface, were interchangeable with all flasks of the same size and admitted attaching and detaching in one-tenth the time.

A foundry making a variety of small bushing cores (½ inch to 2 inches in diameter, by 16 inches long) followed the usual method of black washing the cores after drying and then laying them flat on a level core plate for delivery to the oven for the final core-wash drying. An improved device by which from 8 to 20 cores can be dried on end at one time is shown in Fig. 9. This is simply constructed. The base is cast, the stem is a ½-inch iron rod threaded on one

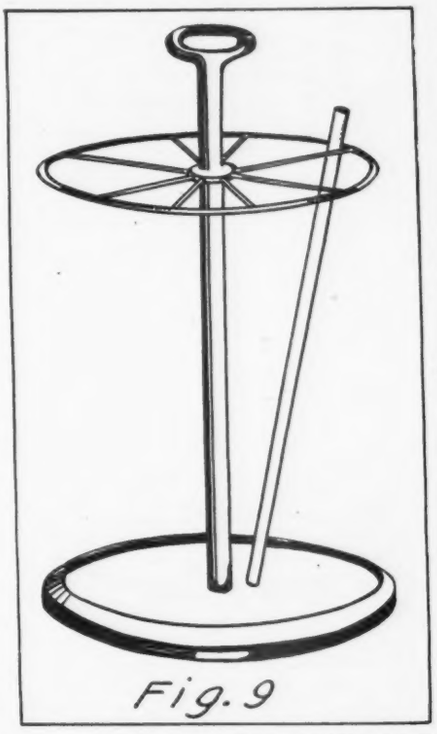


FIG. 9—HOLDER FOR DRYING STRAIGHT CORES AFTER BLACKING

end with a handle bent on the other The upper compartment circle is made by casting a hub upon eight wires of equal length and equidistant from each other. A wire bent to the circle is then spot-welded by acetylene to the points of these eight wires, radiating from the hub. The hub then is drilled, slipped over the stem and secured to it by means of a set screw. In use, each compartment holds from one to four cores standing at an angle to the base and leaning outward at the top. They touch the form at only two points, giving practically an unmarred core surface.

Rammed-in and seamless furnace linings possess many advantages both in service and in renewal. In a barrel furnace it is not difficult to make and use a form or pattern around which to ram the lining material. However, lining a furnace of the Schwartz type, which does not part at the middle, is a different proposition. We lined such a furnace once simply by plastering the lining to the sides, attaining a fair job and average service. However, we don't do it that way now. Instead, we use a collapsible form, an idea suggested by a machine-shop man and worked out by the patternmaker.

Manufacturing a standard product offers an ideal condition for exercising ingenuity. Usually such a product justifies any reasonable outlay of capital to facilitate and increase output. The saving of a single moment of time, an ounce of metal, or measure of energy per unit of production multiplies immeasurably in the vast quantities turned out. Molding machines built to suit some specific job, flasks designed for particular purposes, pattern plates mounted by expensive and enduring methods, special pouring off, shaking out and casting conveying systems, sand mixing, riddling and conveying systems, and cleaning room equipment, offer wide fields for the inventive mind.

Choice of Methods Important

If we had just 100 and no prospect of any more 2-inch globe valve bodies and trimmings to make, we would get out a wood pattern for the body, mount it on a plate and make it on a jolt-squeeze hand drawing machine. The trimmings, we would group on a plate and make the same way. If we had 1000 to make and a guarantee of thousands to follow, we would make metal patterns. We would mount the body with stripping plate, and either buy a molding machine with power lift device or rig up the same device for use on a jolt squeeze machine. For the trimmings, we would make enough metal patterns of each kind to fill a flask, plate mount each kind separately and assign these plates to the most suitable machines.

Jobbing work is a supreme test of the foundryman's ability. It is not difficult to produce automatically close to 100 per cent on types of patterns in service month in and month out; but when the patterns are changing daily and representing all types and classes of work from all types and grades of metal the situation is entirely different. The writer's foundry has played both ends of the game and holds that successful manufacturing, despite its vastly superior showing is not to be compared with high class jobbing. Genius in jobbing is of a different and higher order because the conditions are so widely divergent and the problems decidedly

harder. This probably explains why the average jobbing shop observes ordinary methods and expresses little if any of that progressive spirit so vital to up-to-date manufacturing. Therefore, the idea man in a jobbing shop must be a different and higher type. He must have knowledge, broad vision, sounder judgment, great discriminating powers, pronounced originality and self-reliance, and quick, accurate decision. Neither time nor conditions admit of much experiment; while limited quantities reduce margins of expenditure for equipment and changes. What he tries must be comparatively inexpensive and work from the beginning or a loss is suffered which takes all the profit. So peculiar indeed are his conditions that a manufacturing foundryman changing over to jobbing must forget much of his training and discard many of his principles.

Making Bushings on End

Another field too large to admit of more than a single illustration is that of arranging core prints. Suppose in small orders frequently recurring a variety of 12-inch bushings ranging from a ½-inch to 2-inch cores and from 1-inch to 3 and 4-inch outside diameters, are made. The differential in sizes of both cores and outside dimensions being, say in eighths of an inch. Usually it is desired to pour them on end to keep the core straight and centrally located, molded flat and poured upright, in open end flasks. That necessitates a great number of each sized patterns to accommodate the different sized cores, so the plan is offered of making all patterns with a ½-inch diameter core print and using slip-over liners or bushings to give any diameter desired. This plan will work but at a tremendous disadvantage so it is decided to use solid patterns with detachable end prints, and mold and pour on end. Perhaps this is because the shop has a jolt machine where the ramming can be done quickly and admirably. Despite the best efforts, cores get out of center due, sometimes, to slight shifts in the flask or the core prints and often to the cores mislocating more or less in closing the cope of the mold over them. Fig. 10 shows a circular disk core ½-inch thick and having a center hole ½-inch diameter. It also shows a pattern for pin brass 12 inches long with a ½-inch core print attached to bottom and disk core print attached to the top. Mold a pin brass from this pattern. Take a ½-inch round core 14 inches long and set it in the drag print. Then slip a disk core over the top end of the round core and press it nearly into its own print and the last reasonable chance of the core coming out of center is avoided. If a ¾-inch hole in the bushing is wanted, use a ¾-inch drag print and make the hole in the disk core also ¾-inch instead of ½-inch and similarly for any sized bushing with any sized core. These disk cores can be made cheaply from one or two gang core boxes. They may be used on the bottom print by slipping them over the core print in ramming up.

At one time, nonferrous alloys were chiefly one of two combinations, copper and tin or copper and zinc. We now have copper base alloys containing from 2 to 6 elements in widely varying proportions. Few brass foundries work the same alloys in the same way and yet

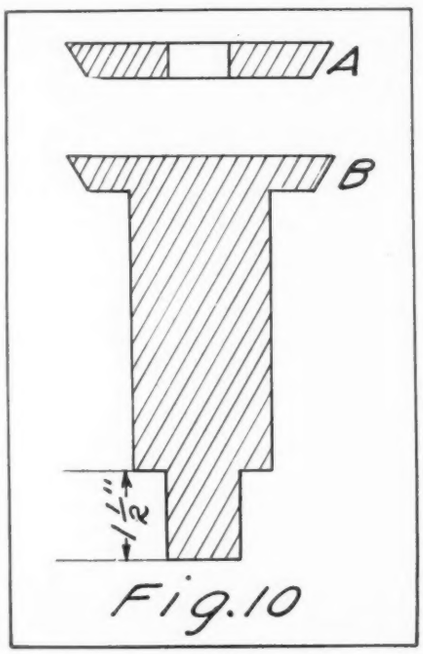


FIG. 10—*A* IS A DISK CORE WITH A HALF INCH HOLE IN THE CENTER *B* IS A SECTION OF PIN BRASS PATTERN WITH A ½-INCH CORE PRINT AT THE BOTTOM AND A DISK CORE PRINT ATTACHED TO THE TOP

many of them get clean metal and solid castings. As a final and conclusive test of the pouring temperature of phosphor bronze we could always rely safely on the appearance of the metal in the sprue head. Though able to judge well by color, viscosity, etc., yet we sometimes were mistaken in these signs. Pouring molds ordinarily prepared, with the metal at too high temperature meant severe sand burning. Pouring too cold produced dull and shrunken castings. We early conceived the idea of preparing at least two molds for metal slightly high in temperature and set these molds at the head of the line. We then would pour these molds with the metal a trifle too hot and use the action of the sprue metal as a basis of judgment to temper down for the remaining molds.

Brazing flanges smooth all over are not easy to make even though the molds be perfect. Poured cold, they shrink and come out with a wavy surface. On first melting, hot metal develops much white powder (zinc oxide) which enters the mold in pouring and shows on the cope of the casting. By using yellow brass pipe or chips with copper, instead of zinc with copper, pleasing castings result. However, the brass melter is not always sure of the metals contained in yellow pipe or the proportions of zinc to copper. Pouring a second melting of virgin metals combined is a rather expensive solution. A cheaper plan is to combine copper 72, zinc 28 and cast in pigs. Then use this prepared alloy along with virgin copper in the ratio of two parts copper one part alloy. This gives copper 86, zinc 14 and results in sound castings, especially when used with gates from preceding heats.

Oxide in Iron an Undetermined Question

By H. E. Diller

Question—Does iron oxide enter gray iron melted in the cupola, and remain there becoming emulsified? Would oxide be more likely to be taken up by a mixture of pig iron with steel scrap? If the oxide is taken up by the metal how is it possible to hold it in the presence of so much carbon and silicon?

Answer—Oxygen does enter iron melted in the cupola if conditions are highly oxidizing. Whether this is taken up in the form of oxide and held in that form, or whether the gas is simply occluded in the metal has not been definitely proved. If the oxide is formed it no doubt does remain in the iron for some time as all chemical action requires time for its completion. Were the iron held at a high temperature for a sufficient length of time in a reducing or neutral atmosphere all oxygen probably would be removed from it, certainly none would continue to exist as the oxide. As it is, the air strikes the molten iron as it drops through the coke bed in the cupola, and if there is an excess of air, some of the iron as well as carbon, manganese and silicon are oxidized. The oxides which are not gases tend to go off in the slag. On the other hand if oxygen is occluded in the metal, it may be held there until the iron sets. Up to the present no method of generally acknowledged accuracy has been developed for determining the amount of oxygen in iron. It has been shown that steel or small particles of iron such as borings will tend to oxidize in the cupola.

Manufacturing Chilled Iron Car Wheels - IV

Different Types of Chillers Are Described and Methods of Annealing Fully Detailed

BY H. E. DILLER

BEFORE following the progress of the car wheel to the annealing pits, the chiller and its application in molding should be considered. The chiller's function is to draw the heat from the molten metal as rapidly as possible and as iron is a good conductor of heat, it is employed for the purpose. It is necessary to coat the surface of the chiller which comes into contact with the molten iron, the double function of the coating being to preserve the life of the chiller and to give a better surface on the tread and flange of the wheel. One method of coating employs a covering of shellac. This is applied before the men go home at night. The chiller may be used with no further treatment but some foundrymen use an additional coating of medium or light mineral oil before putting it in the mold. At other foundries no shellac is used but the chills are coated with a mixture of lard oil and some pigment such as iron oxide or coke dust. At one plant cylinder oil is substituted for the lard oil and this is thinned with kerosene, as is also the lard oil mixture in the winter months.

When hot metal enters the mold and strikes the chiller, the coating instantly is changed into a reducing gas and leaves a thin deposit of carbon on the mold. The gas causes a bubbling in the metal as it rises in the mold and the ebulition causes the iron to carry up with it any particles of sand which may have entered the mold. If this reaction were not present, dirt in the iron, when it rises to the top of the metal and is drawn to the side against the chiller would stick there because the metal would be cool and sluggish, and would not have life enough to carry the dirt up with it. The use of the coating prevents moisture forming on the chiller, thus reducing chill checks and producing a smoother tread.

The metal from which the chiller is made also has an influence upon its length of life. A chiller made from soft, open-grained metal does not last as long as one made from a closed-grained iron. For this reason many foundries cast them from the same metal as that from which they make the wheels while others modify the mixture somewhat. A recommended procedure is to cast the chillers from the first tap of the cupola, which is inferior for car wheels. Common chillers made in this way will produce from 300 to 600 wheels.

After the chiller is cast it is carefully machined to diameter and precautions must be taken to see that it is a true circle. When it has been used for some time, the diameter is likely to be increased due to wear on the surface of the tread and

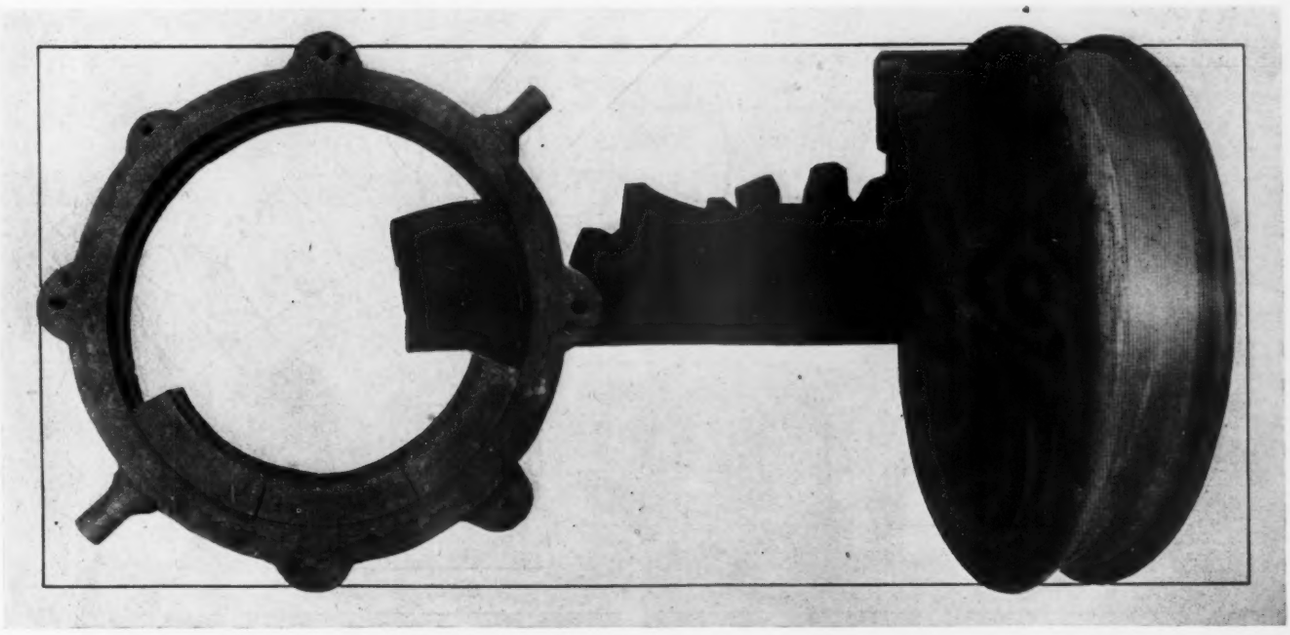


FIG. 31—DOUBLE FLANGE WHEELS ARE MADE WITH A SEGMENT CHILLER—THE SEGMENTS ARE PLACED AGAINST A SHOULDER IN A CAST-IRON CONTAINING RING—THEY FALL OUT READILY WHEN THE CHILLER IS RAISED AFTER CASTING THE WHEEL

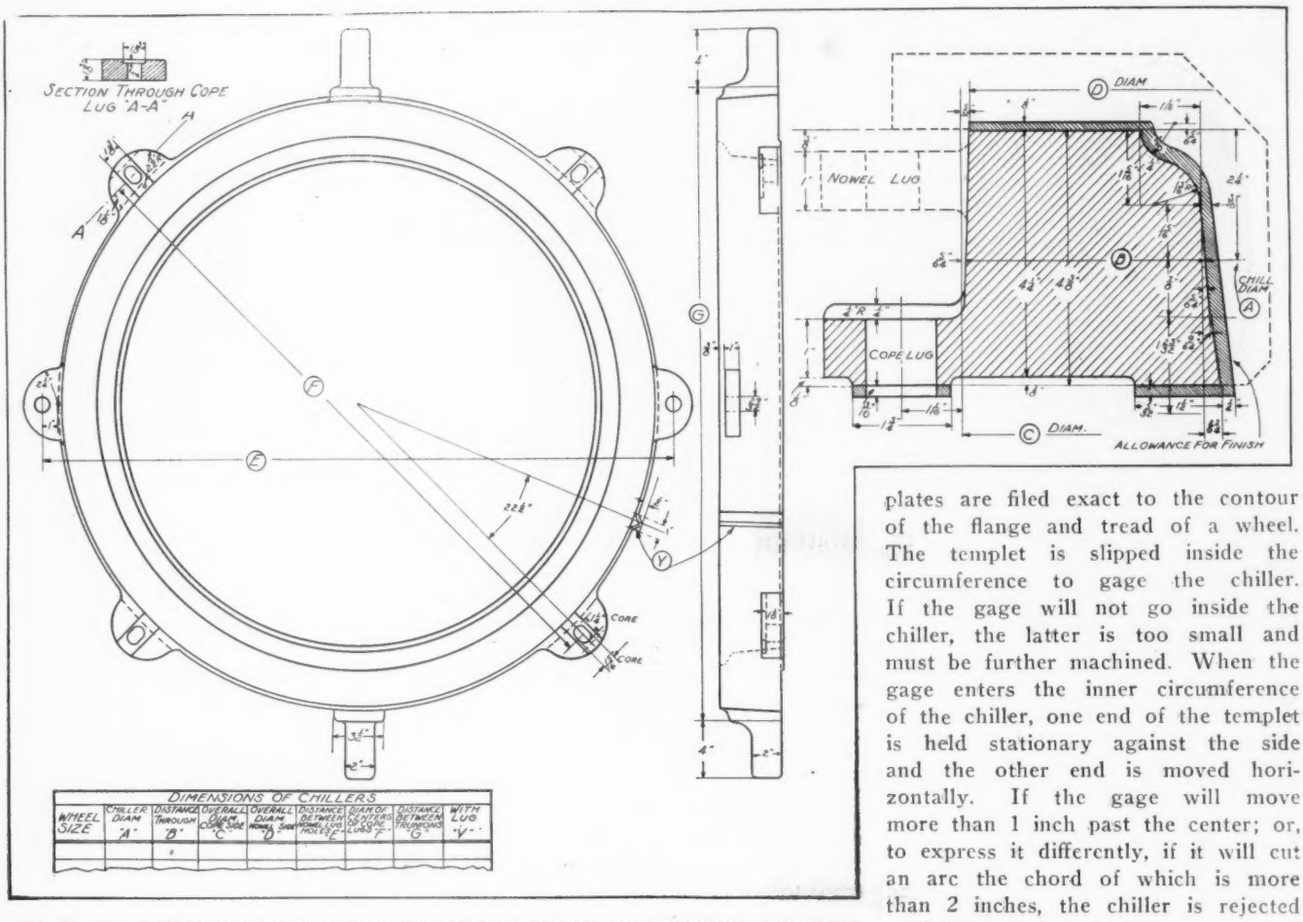


FIG. 32—THE COMMON CHILLER IS CAST IN ONE PIECE WITH LUGS AND TRUNNIONS—DIMENSIONS ARE GIVEN FOR THE 33-INCH WHEEL

flange. Therefore, the foundry occasionally must measure the chillers to find whether they are correct in diameter. A gage similar to the one shown in Fig. 35 enables a quick check to be secured. The gage consists of a board with two sheet-steel plates screwed on the ends. These plates are filed exact to the contour of the flange and tread of a wheel. The templet is slipped inside the circumference to gage the chiller. If the gage will not go inside the chiller, the latter is too small and must be further machined. When the gage enters the inner circumference of the chiller, one end of the templet is held stationary against the side and the other end is moved horizontally. If the gage will move more than 1 inch past the center; or, to express it differently, if it will cut an arc the chord of which is more than 2 inches, the chiller is rejected as being too large.

The common chiller is a solid ring with lugs and trunnions. One of these is shown in Fig. 32. The size of the cross section is governed by the amount of metal required to carry away the heat from the wheel, and is

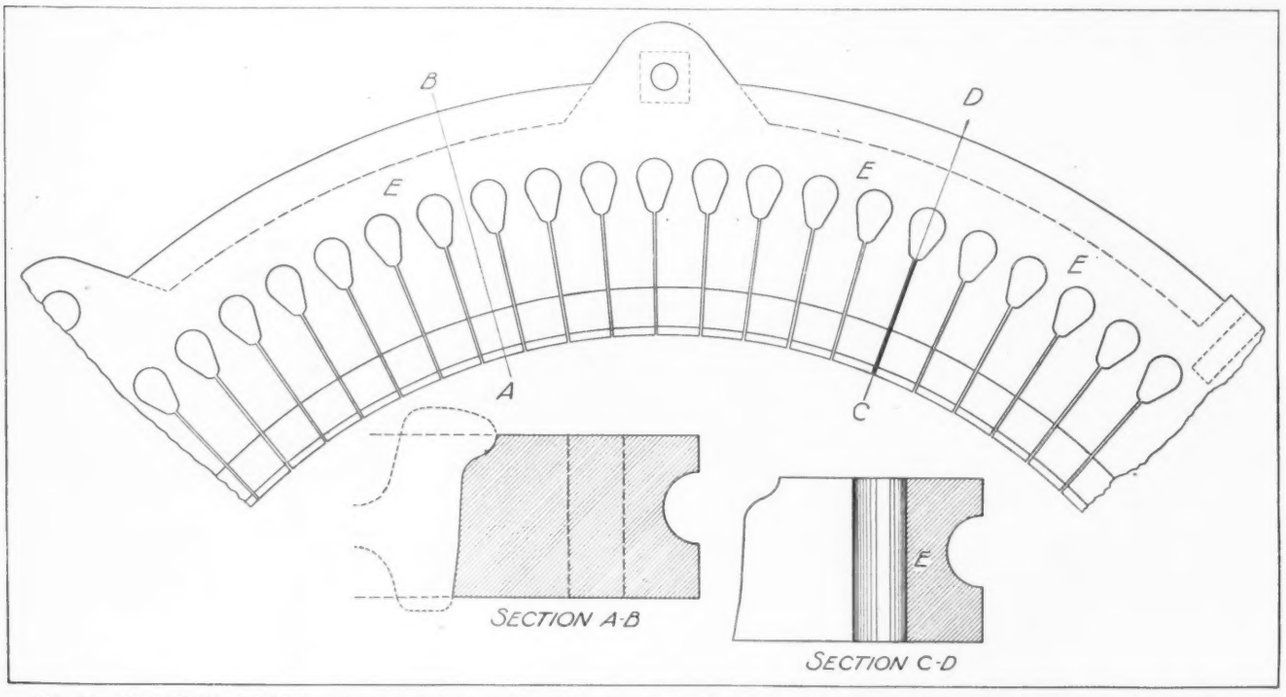


FIG. 33—CONTRACTING CHILLERS HAVE THE INNER CIRCLE MADE OF SEGMENTS WHICH CAN LENGTHEN UNHINDERED BY LATERAL PRESSURE—LARGE HOLES IN THIS CHILLER ARE CAST WITH SAND CORES—THE SLITS ARE FORMED BY SHEETS OF ASBESTOS, SHELLACED AND FIT INTO THE CORES

kept as light as possible on account of the difficulty in handling. The effect of heat on this chiller is the same as on a steel tire. The action of heat is utilized to expand a steel tire for shrinking it on a wheel center. However, with the chiller the expansion by heat is a disadvantage. As soon as the molten iron touches the chiller, the inside layer tends to expand while the outer layer is not immediately affected. This produces internal strains in the chiller and tends to shorten its life. The strains also have a tendency to warp the chiller and cause it to become out of round. The heat continues to cause the chiller to expand, while the metal of the wheel from which heat is being extracted begins to contract. These two reactions carry the wheel surface and the chiller in opposite directions and their contact soon is broken. Of course, after the chiller is no longer in contact with the wheel its further chilling effect is lost. Much thought and experimentation have been devoted to endeavoring to overcome these defects of the common one-piece chiller.

FIG. 34—SLOTS ARE MADE IN THE ASBESTOS-CUT CHILLER TO THE LEFT WITH THIN PLATES OF SHELLACED ASBESTOS—THE SEGMENTS IN THE CHILLER TO THE RIGHT ARE LOOSE PIECES CAST INTO THE CONTAINING RING

A split chiller consisting of two semicircles was tried. It had the disadvantage of making wheels which were not circular. The portion of the wheel in the center of the chiller, half way between the splits, was larger than the portion at the ends of the sections. This probably was caused by contraction of the metal causing the ends to bend inward and follow the contracting wheel.

Several patented contracting chillers have been brought out based on the principle of a broken inner ring. In some cases the chiller is in a single casting while in others it is made up of an outside solid ring in which segments are fitted to make up the inner circle which comes in contact with the casting. The theory of these chillers holds that the segments, as illustrated in Figs. 32 and 34, are free to expand when the hot metal strikes them, while the outer solid ring acquires heat much less rapidly. The heat causes the segments to lengthen and follow the casting which shrinks as soon as it sets. The expansion, or lengthening of the segments, continues until the ends of the segments come together forming a solid ring. Then the action becomes the same as though the chiller were a solid circle; the circumferential expansion of the segments expands the ring and causes it to take the opposite direction from the shrinking wheel. However, the segmental chiller follows the contracting wheel for some time while the common, one-piece, solid chiller tends to part from the wheel as soon as it is cast. The effect of contraction in the wheel may be realized when it is pointed out that the chiller for a 33-inch wheel is made with a 33½ inch inside diameter.

Fig. 33 gives the details of a contracting chiller which is cast in one piece. The holes behind the slots are cast in, being formed by sand cores. The slots are made by thin sheets of asbestos paper which are shellaced and then inserted in the cores that produce the slots. The asbestos sheets are 0.028 inches thick when shellaced and form a slot 0.025 inches wide. A section of one of these chillers is shown at the left in Fig. 34. This chiller is similar to the one known as the barr chiller. The main difference in the two chillers is that the section which is

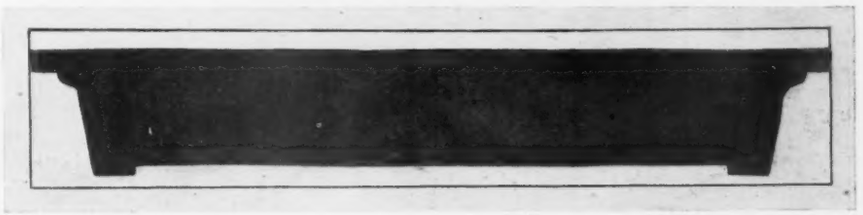


FIG. 35—CHILLERS ARE DISCARDED WHEN THEY BECOME TOO LARGE—A GAGE INDICATES TO THE FOUNDRYMAN WHEN THIS POINT IS REACHED

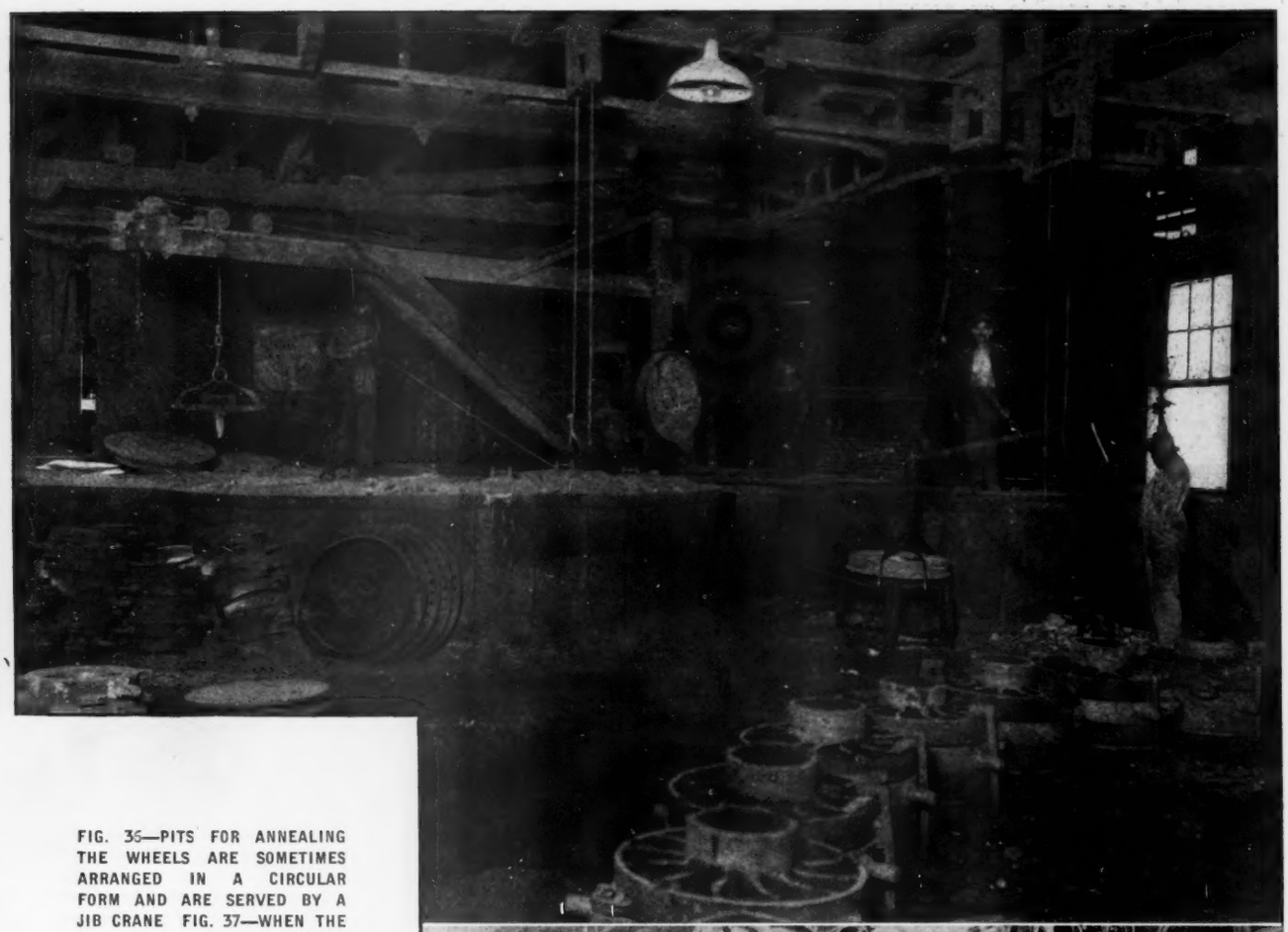


FIG. 36—PITS FOR ANNEALING THE WHEELS ARE SOMETIMES ARRANGED IN A CIRCULAR FORM AND ARE SERVED BY A JIB CRANE FIG. 37—WHEN THE PITS ARE LOCATED IN ROWS THE WHEELS ARE HANDLED BY ELECTRIC CRANES, OR BY AIR HOISTS CARRIED ON TROLLEYS

grooved by the asbestos is solid in the barr chiller and must be cut by sawing. As a chiller is too hard to saw readily when made from the regular car-wheel iron, a foundry making car wheels can not cast the barr chiller and saw it unless a special mixture is used in the cupola. This has induced some foundries to change from the barr to the asbestos-cut type.

Another chiller, which is designed with an inner ring made of segments, is shown to the right in Fig. 34. This is a patented device in which the segments are made separately and cast into a solid back which binds them together.

Due to the solid construction of the common chiller, great internal strains are set up in it when a wheel is cast, and so its life is shortened on account of heat cracks, warping and breaking. The construction of the contracting chiller, allowing a freer movement of the inner circle, makes it less subject to warpage and tends to preserve its true circular form. The contracting chiller has a much longer life than the common chiller.

However, the greatest objection to the use of the contracting chiller is the necessity for applying a filler to close the intertices between the segments on the side against which the wheel is cast. Varnish is used for this purpose and when it is not properly applied to the entire chilling surface, fins will form on the tread of the wheel cast against it. Such wheels then must be ground to remove the fins.

The filler, or varnish used on the chiller formerly was based on shellac, but since the price of shellac has advanced, some foundries have substituted rosin. The gum is cut with alcohol and a filler, such as ordinary coke dust, is added to thicken it. This usually is applied in the afternoon while the chillers are still warm from their day's use. The liquid is rubbed well into the slots and all surplus varnish is wiped from the chiller. Before making the mold the following day, the face of the chiller is oiled with a mixture of machine oil and kerosene.

Results of Experiments

A firm which has experimented extensively with different chillers found that the contracting chiller produces a wheel in which the chill was uniform around the entire circumference, while with the use of the common chiller, a variation of as much as ⅜-inch in the depth of the chill was found at different points on the same wheel. This company also found that wheels cast from the contracting

FIG. 38—WHEELS ARE CARRIED BETWEEN TWO BANKS OF PITS AND RAISED BY AIR HOISTS

chiller were truer circles than wheels cast from the common chiller, especially after both types had been used some time. The defects from chill cracks were shown to be less with the contracting chiller. The action of the segmental style in following the wheel as it contracted was found to give denser metal in the chilled portion of the tread and flange of the wheel, but the gray-iron towards the center of the wheel was not noticeably affected. This also may be assumed from the fact that when wheels are cast from these different chillers, the wheel from the contracting chiller will be somewhat smaller than the one from the common type of the same inside diameter.

The experiments from which the foregoing conclusions were reached were made under identical conditions for the different types of chillers. While one floor was poured into one style chiller another floor was being poured into another type of chiller and the wheels from the two floors were compared by drop test, tape measurement and inspection of the broken wheel, as well as by service tests.

A Different Type Chiller

Wheels which have a double flange require a type of chiller that differs from the single-flanged wheel as, obviously, it would be impossible to remove a circular chiller from the wheel when cast. One of these wheels with the chiller used is illustrated in Fig. 31. The chiller is made of a solid periphery into which segments are fitted. These segments lay against a ridge in one side of the containing band and are free at the other side. When the wheel is cast and lifted from the mold the segments are free to fall out and release the chiller from the casting.

It has been mentioned, that as soon as the wheels are shaken out they are carried from the molding floors to the annealing department on the hotwheel cars. As has been stated, those usually run on narrow

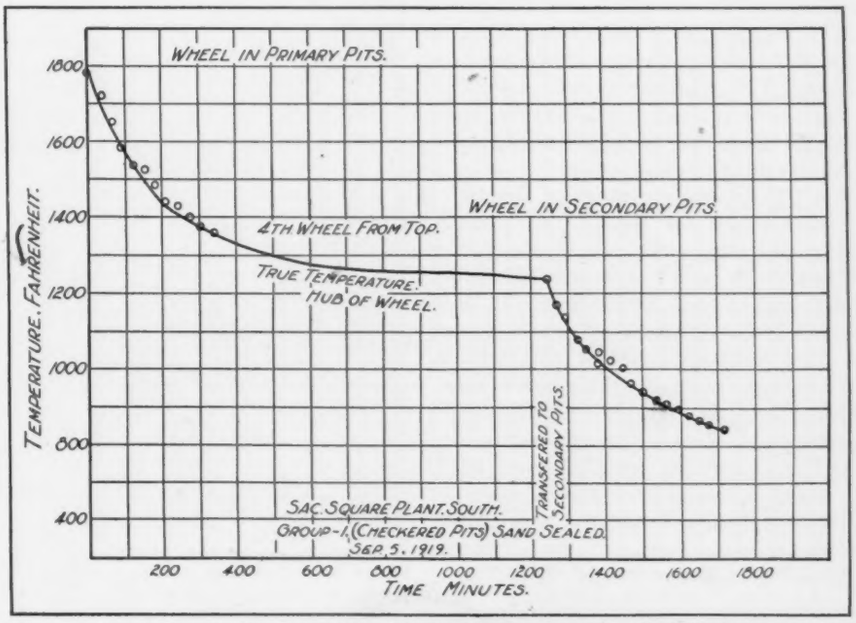


FIG. 39—THE CURVE SHOWS THE DROP OF TEMPERATURE IN THE ANNEALING PIT AND THE EFFECT ON THE TEMPERATURE OF TRANSFERRING THE WHEELS TO A SECONDARY PIT AFTER THE FIRST DAY

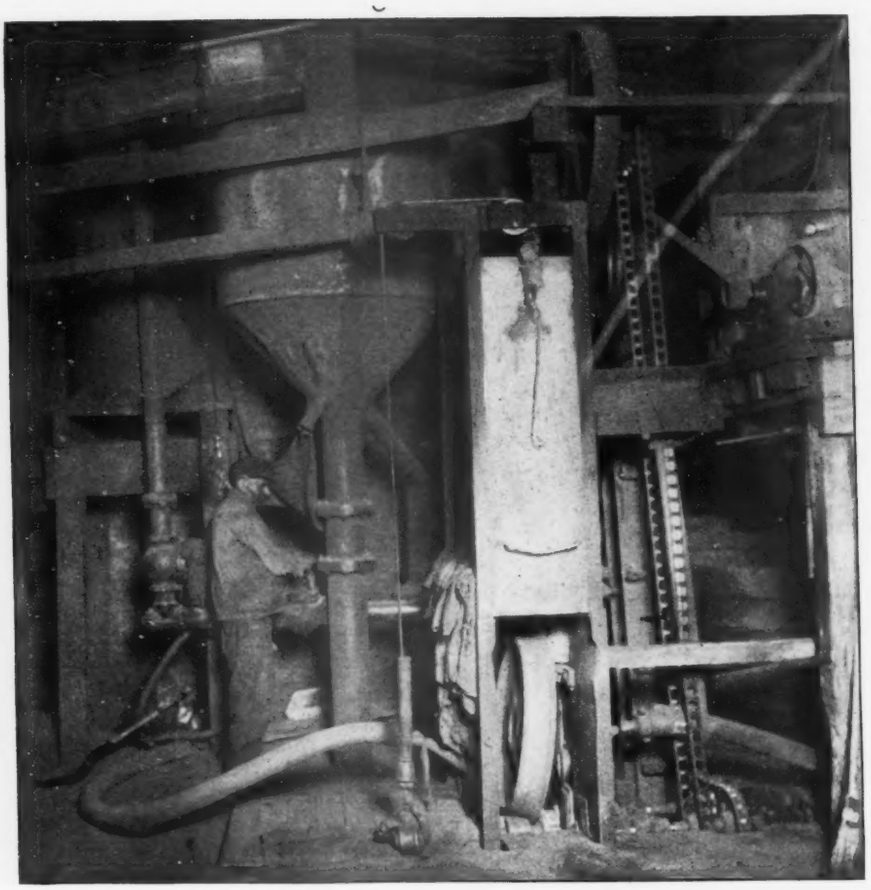


FIG. 40—A WHEEL IS PLACED ON GROOVED ROLLERS WHICH REVOLVE IT WHILE IT IS BEING SANDBLASTED

gage tracks which are laid along one side of the foundry at right angles to the direction of the molding floors. The hot-wheel cars are connected to each other in a manner similar to the hotmetal trains and all move together. This speeds up the operations connected with loading the wheels. The train is operated from a cage about half way from the end of the foundry to the annealing section. The operator is able to judge the correct time to move the cars, which start off slowly, to give the workmen an opportunity to release the wheels and get clear of the train.

Commonly the floor of the annealing department is raised above the level of the molding floor. This saves the expense of excavation. It also gives the workmen a better opportunity to take hold of the wheels, especially when air hoists are used. The hot-wheel train usually runs along the side of the annealing department on the foundry floor level. Sometimes the track extends into the annealing department cutting it into two sections. These two systems have the common merit of providing a long line of track where the cars may be placed so as to carry the wheels to the different pits.

A tunnel, built by the walls of the section of the annealing department, through which the tracks for the hot wheel cars extend is illustrated in Fig. 38. Steel beams extend across the annealing room at right angles to the hot-wheel track and are so spaced that a beam is above each line of pits. The beams support trolleys which carry air hoists to lift the wheels from the cars. These are spaced on the same centers as the cars in the train, so when one of them is stopped under a hoist all cars on the train are similarly located. To the right of this illustration may be seen the rods used for scraping the sand from the hub of the wheel.

Another system for pitting the wheels is illustrated in Fig. 37. By this method an operator in the cage of a traveling crane controls hooks which pick up and carry two wheels, one on each side of the crane. In this system a crane is required for each two lines of pits, but these lines may be made longer than in the other system without appreciable disadvantage, for the cranes travel considerably faster than a workman pushing the air hoist in the system first described.

Like the molding floor, the annealing department is sometimes laid out on the circular system. In such

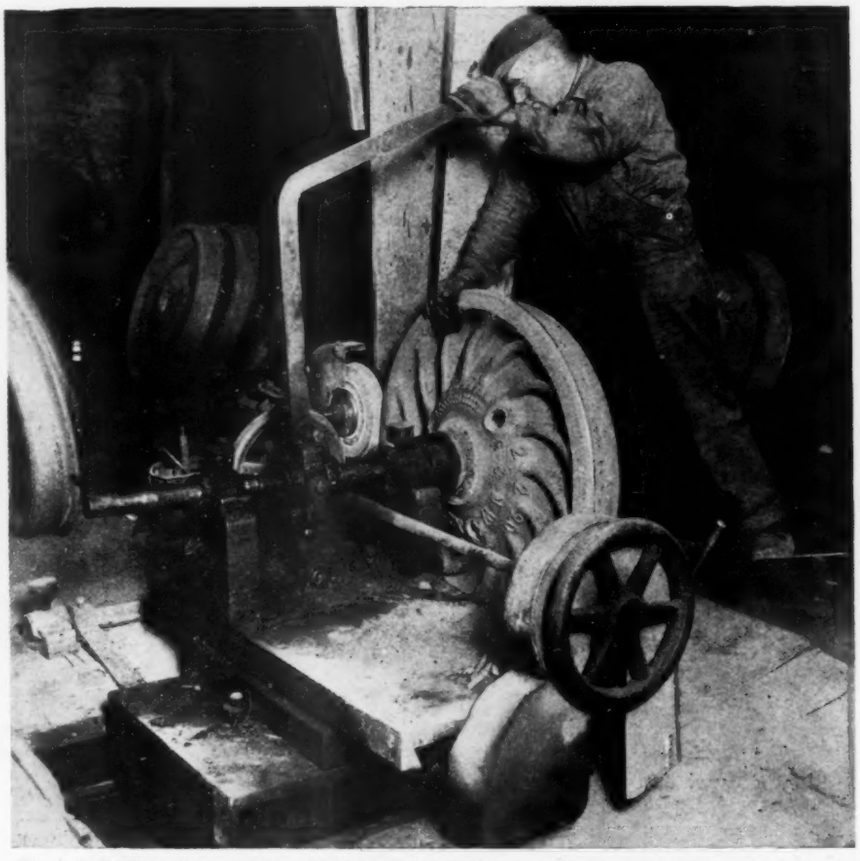


FIG 41—WHEELS ARE GROUND RAPIDLY—THE OPERATOR PRESSES THE WHEEL AGAINST THE GRINDER BY MOVING A FOOT LEVER AND SHIFTS IT WITH A HAND LEVER

cases the wheels are pitted with jib cranes which swing across the pits. Fig. 36 illustrates an annealing department of this type. This foundry also utilizes the circular system in the molding department, as may be noted by the arrangement of the flasks in the foreground. Two styles of hooks for holding the wheels may be noted. The wheels are picked from the molds by hooks which take hold at the circumference, while they are placed in the pits with hooks that engage the hub. A hook of the former style may be seen holding a wheel at the right of the illustration. The second type hook hangs on the jib crane.

The annealing pits are steel tanks lined with firebrick washed with clay. They are set a few inches from each other and the intervening space is filled with brick in mortar or some other heat resisting and insulating material. The pits are heated before the wheels are put in them either by wood fires, or by gas or oil. After the pits become heated no more heat is used to maintain the temperature than is given off by the wheels which go into them, unless there is a shut down of part or all of the foundry.

The depth of the pit governs the number of wheels which it will hold. This number varies considerably in the different foundries. Some foundries have pits which do not hold more than 12 while the pits in other foundries will hold as many as 30 wheels. However, the diameter of the pits is practically the same in all foundries, being only slightly larger than the standard 33-inch wheel. The object is to provide as little spare space as possible and yet to allow ample clearance to permit the wheel to be placed in the pit without difficulty. Cast-iron caps are used. Frequently these are covered over with a layer of sand to help maintain the heat in the pit. Again, a cover is placed over the wheels and another cover is placed on the pit.

By filling scattered pits each day the temperature is kept more constant than if an entire section of pits was filled at the same time and then emptied on the same day. A common method for scheduling the work as it is placed in the pit and removed includes a diagram of the layout of the pit floor on a board. The locations of each pit is marked with a black circle and the date the pit is to be pulled is indicated on the circle with chalk.

Wheels are held in the pit four and, in some cases, five days. They then are taken out and allowed to stand on the cooling floor for one day. This is advisable because the wheels as taken from the pits are too hot to touch with the hands. The wheel at the top of the pit on removal will have a temperature around 800 degrees Fahr. and the wheel from the bottom averages 200 degrees hotter than this. The difference in degree of cooling of the wheels in the pit is watched closely by the annealer and in some foundries a record is kept of the wheels in the top of the pit. If the annealing is too irregular, the effect may be detected by the color of the oxide on the wheel. The best practice causes a red oxide to form on the wheels. However, when the upper wheels cool too quickly they will develop a blue scale.

FIG. 44—MICROSTRUCTURE OF THE CHILLED SECTION OF A WHEEL BEFORE ANNEALING—MAGNIFIED 100 DIAMETERS FIG. 45—THE ANNEAL BREAKS DOWN THE COARSE CRYSTALLINE STRUCTURE INTO FINER GRAINS

FIG. 42—MICROSTRUCTURE OF THE GRAY-IRON PLATE OF A WHEEL BEFORE ANNEALING—MAGNIFIED 100 DIAMETERS FIG. 43—SAME AS FIG. 42, AFTER BEING ANNEALED—NOTE THE GREATER PERCENTAGE OF GRAPHITE

Annealing relieves the shrinkage strains and this formerly was thought to be the only function of this treatment. In recent years a large amount of investigation has been carried on to study the effect of annealing on the structure of the iron. It has been determined that the anneal enlarges the ferrite crystals in the gray-iron portions by precipitating part of the combined carbon as free or temper carbon. This softens the gray portion of the casting, but the same effect is scarcely noticed in the white, chilled iron which remains almost as hard after annealing as before. The results as indicated by the study of the microscopic structure have been confirmed by brinell hardness tests. The tread of the wheel shows a brinell hardness number ranging from 450 to 500, and the gray-iron section will have a hardness number ranging from 120 to 210, depending largely upon the anneal. Before annealing, the gray iron may have a brinell number as high as 360 while the number of the white iron seldom is lowered more than 50 points by the anneal. From this it may be seen that the gray iron is more sensitive to variation in the anneal than is the white iron.

The microstructure of the car

wheel before and after annealing is shown in Figs. 42 to 45, which are micrographs magnified 100 diameters. Figs. 42 and 43 illustrate the gray-iron section of the plate of a normal wheel before and after annealing, respectively. It may be noted how the cementite shown in the white blotches in Fig. 42 has broken down into pearlite and graphite as illustrated in Fig. 43. Similarly, the effect of annealing the chilled-iron is shown in Figs. 44 and 45. The coarsely crystaline structure of the unannealed chill, Fig. 44, is refined to a finer structure as may be noted in Fig. 45.

The length of time of the anneal was determined by experience years ago when practically nothing was known of the metallurgical side of iron founding. This annealing period has been little changed, although something has been done in the way of designing pits to carry the surplus heat from the bottom to the top and so to equalize the temperature of the different parts of the pit. However, tests have been started recently to determine whether it would be possible to shorten the length of time of the anneal. One method suggested is to transfer the wheels to a secondary pit after they have soaked in the first pit for about one day. A diagram of a temperature curve taken at the hub of the fourth wheel from the top of a pit is shown in Fig. 39. This indicates that the wheel went into the pit at slightly less than 1800 degrees Fahr. which is the average temperature at which wheels are pitted. The wheel then cooled with comparative rapidity to the region of 1300 degrees when the cooling gradually became slower. For several hours the temperature remained almost stationary around 1250 degrees. This same slow rate of cooling would have continued throughout the remainder of the anneal if the wheels had been allowed to stay in the pit, and after three more days the wheel would still have been hotter than 800 degrees. This would have shown a drop in three days about equal to the drop in the first third of a day. However, after the wheels had soaked 1250 minutes, or slightly more than 20 hours, and were cooled to a temperature below the recalescence point, the wheels were transferred to a specially designed secondary pit which allowed them to cool more quickly. More detailed data is being acquired on this method before it will be pronounced a successful procedure.

From the pits the wheels are taken to the cleaning room. This department is not elaborate in any car wheel foundry. The treads of the wheels usually need little attention and it is comparatively easy to clean the sides of the wheels. Both hand cleaning and sandblasting are used to remove sand from the sides of the wheels. The sandblast machines used all are of similar design. The procedure may best be described by referring to Fig. 40 which shows a wheel in the sandblast. A wheel is rolled into the compartment and the door is closed. The operator then turns on the blast which strikes the wheel as it is revolved by the two grooved rollers in the floor, on which it rests. These rollers are moving continually and attention need not be given to see whether the wheel is revolving. After the blast has been operating for approximately 10 seconds, the operator shuts it off and raises the door. A workman pulls out the wheel and places it ready for the weighing operation, while another rolls a second wheel into the sandblast and closes the door. The complete cycle of operations is over in less than a minute.

As has been noted in describing the contracting chiller, the use of this style chiller necessitates grinding the tread and flange to remove fins. Even with the solid chiller, a grinding machine frequently is required to take off little shifts and fins on the flange. One of these machines in operation is illustrated in Fig. 41.

The abrasive wheel, shown in the background turns continually. In its normal position the car wheel does not touch this revolving wheel. Contact is made by the operator who moves the wheel forward by pressing the lever on which his foot rests. The wheel is shifted sideways by the lever in the man's left hand. With his right hand he slowly revolves the wheel.

The complete operations in the manufacture of the wheel have been outlined. But the wheels are not ready for shipment to the customer for they must first stand a rigid inspection by a representative of the railroad to whom they are to be shipped. These tests will be described in a future article of this series.

British Foundries Feel Automotive Drain

The British molders' strike of last autumn has had a singular sequel in the Staffordshire district, which is a great center for the manufacture of rolls and heavy mill machinery. In the heart of the iron works district at Tipton, some of the largest automobile manufacturing companies have their headquarters and they are largely under the management of managers trained in America. These concerns are aiming at the largest possible mass production and, being short of molders, they have not hesitated to offer the men wages largely in excess of those which formed the basis of the recent settlement. The molders at the roll casting works are highly skilled men able to earn about $19.70 a week, but under the liberal terms offered by the motor builders they are now able to earn as much as $35.46 a week, and they have, accordingly changed their employment. The roll founders are not disposed at present to outbid the motor builders and as they have lost a number of their men, the production of heavy rolls has been reduced.

Little Magnesite Imported Last Year

The production of magnesite in United States in 1919 was about 30 per cent less than in 1918, but nevertheless was greater than any year prior to 1917. The output of crude magnesite was reported by the geological survey to have been 162,000 tons in 1919. It is thought that the large production should be satisfactory and encouraging to domestic producers, for even as late as June, 1919, it was expected that receipts of foreign magnesite would practically terminate the domestic industry. The imports were not received as expected and the demand for magnesite for refractories and plastic wares had to be supplied from domestic sources.

Toledo Brass Foundry Nears Completion

The Nonferro Foundry & Pattern Co., 1361 West Bancroft street, Toledo, O., which recently was incorporated, has a plant which it is equipping with machinery and tools for a complete foundry and pattern shop. The company expects to be in full operation soon, and will manufacture brass, bronze and aluminum castings; wood and metal patterns. Officers of the company are: President and general manager, F. G. Simon; vice president, R. Eppich; treasurer, H. J. Badhorn; secretary, Joseph Huther, and assistant secretary, A. R. Rellinger. P. A. Gaynor, former manager of service and sales for the Bryan Pattern & Machine Co., Bryan, O., will hold a similar position with the company.

The Independent Pneumatic Tool Co., Chicago, has removed its Detroit office from the David Whitney building to the Garfield building.

Heat Treatment Vital in Welding

The Size, Shape, Weight and Material of Which the Casting Is Composed Are Factors in Determining How High the Casting Should Be Preheated

BY GEORGE B. MALONE

THE knowledge and skill required to weld castings in any kind of metal is one of the most important accomplishments a foundryman can possess today. In many cases it is possible to salvage an expensive casting; a practice and process unheard of a few years ago. During the war period, welding was practiced more extensively than ever before on account of the abnormal demand for all kinds of castings. Millions of pounds of castings were salvaged by welding, and accepted by the government inspectors as being perfect in every particular. The writer repaired over 2,000,000 pieces in one of the large industrial plants. The aggregate saving of the company from these operations amounted to $13,000 a week. Many foundrymen have yet to learn that a large proportion of the castings usually consigned to the scrap pile can be made commercially perfect by the welding process.

A large company with which the writer is familiar, which manufactures pumps, would not permit any of its castings to be welded until a few years ago. If a pump cylinder was slightly porous it was brazed. If the brazing operator was lucky enough to save the cylinder it would be camouflaged by painting, etc., and forwarded to the customer. While the practice is common, it is the writer's opinion that brazing should not be employed except for making minor repairs to castings. In the first place, a microscopic examination will reveal hair-line cracks in brazed sections, and, in the second place, all the time and labor spent in preparing the casting for brazing will be lost if the job does not turn out satisfactorily.

Importance of Preheating

The proper way to repair a casting, particularly a cylinder, is to preheat it and then weld it. The temperature to which any casting should be preheated depends upon its shape, size, the purpose of the preheating and the metal of which the piece is made. To illustrate the difference in preheating temperatures, consider first a heavy piece of cast iron the shape of which should not produce any contraction strains while cooling, and then consider a light complicated casting like an automobile cylinder. In the first case it is evident that the purpose of preheating is to save gas and labor, and that the preheating temperature can be raised to a cherry red because there will be no danger of distortion or cracking. In the second case the conditions are entirely different, the preheating must not be carried to so high a degree as to warp the cylinder but must be carried high enough to permit the casting to contract without cracking when cooling.

Welding Large Steel Castings

In this case, the amount of gas saved by preheating is negligible. In the first case the temperature may vary from 1200 to 1500 degrees Fahr., while in the second case it should not exceed 800 degrees Fahr. In other cases where the style or type of cylinder is quite simple a lower temperature is sufficient. To attain the highest degree of efficiency, the degree of heat should be measured by some suitable recording instrument. Great care must be exercised in welding hollow castings such as radiator castings, water backs, etc. This type of casting must invariably be preheated. The only special instructions that can be given in these cases are that the welder use all precautions.

Large steel castings may be welded without preheating, where wear is not a factor. It is preferable, however, in all cases, particularly where iron or steel castings lie in a damp place, or where they are subjected to intense cold, that they be brought to the welding temperature slowly. The reason for this is that as soon as the welding torch is applied to a cold casting the chances for crystallization are good and not only will a poor weld result but in a great many cases the casting will be rendered unfit for use.

The salvage of small castings by the welding process is something that should receive more consideration from the foundrymen that it does at the present time. All foundries figure a certain percentage of lost castings. This loss can be reduced to a minimum and large savings made financially if the foundrymen will install welding equipment. The foundryman who has not yet installed a welding outfit is as far behind the times, in the writer's opinion, as the printer who is using an old-fashioned hand press.

Great care must be exercised in repairing brass and bronze castings by the welding process. The following incident, which took place in a plant making pistols for trench warfare illustrates this point. The pistol grips were made of bronze. The maker was at his wit's end to know how to reclaim castings which contained sand holes when received from the foundry. The writer was consulted and upon visiting the plant found that the tool department, which had charge of all welding operations, was using Tobin bronze on the job. When the grips were polished they showed a bright yellow streak where the weld was made. The government inspector would not pass them and hundreds had been rejected. The difficulty was overcome by using a welding rod carrying a higher copper conten than the metal in the casting. After personally welding ten grips they were polished and placed before the inspector who passed them.

When it is desired to weld a casting, a welding rod of the same analysis as the casting should be used. Little difficulty will then be experienced in salvaging castings. This is particularly true in the case of brass or bronze castings which may have to be polished. They will show a different color at the weld if this precaution is not observed.

Welding Monel Metal

Many foundrymen have experienced difficulty in welding monel metal castings. They are really not any harder to weld than the ordinary iron castings if the proper procedure is followed. The analysis of monel metal shows a large nickel content and a nickel casting cannot be welded without reheating. On account of the combination of copper with nickel

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From a paper read at the Philadelphia convention of the American Foundrymen's association. The author, George B. Malone, is connected with the Bayonne Steel Casting Co., Bayonne, N. J.

in monel metal it is apparent that the casting must be brought to a rather high temperature, say 1600 degrees Fahr., before the weld is attempted. After the casting has been welded it should again be brought to approximately 1500 degrees Fahr., and placed in hydrated lime to prevent any air from getting to it.

In many cases the foundrymen will tell you that when the weld was made the casting looked sound but 10 minutes afterward it was cracked. The reason for this is that proper care was not taken with the casting after the weld was made. It should have been allowed to cool slowly under a covering of hydrated lime which is the best substance the writer is acquainted with and which he always uses for this purpose.

How and Why in Brass Founding

By Charles Vickers

Gas Fittings Stand High Pressure Test

Can you please inform us in regard to the formula for gas fittings? Can this alloy be made to retain a water pressure of 40 pounds per square inch, and can it be cast by the ordinary methods in use by manufacturers of plumbers' supplies?

Gas fittings are generally made of scrap metals because the price at which they are sold does not permit the use of new metals. Yellow brass chips and yellow brass ingot are suitable material for this class of brass castings. However, if a new mixture is desired, the following alloy will be suitable: Copper, 66 per cent; zinc, 30 per cent; lead, 2.50 per cent, and tin, 1.50 per cent.

Yellow brass of the above formula ought to withstand pressures of 40 pounds per square inch, provided it contains no aluminum as an impurity, and is cast free from zinc oxide. However, it cannot be expected to withstand 300 or 400 pounds per square inch pressure. A few castings might stand these pressures, but unless the alloy is handled very skillfully in melting, molding and pouring, the production loss will be high due to failure under hydraulic pressure.

The methods used by makers of plumbing goods are correct for any alloy of yellow brass. Pour the metal strongly at a lively temperature, always keeping the heads filled. Needle vent the tops of flanges, and draw parting vents from all angles of the castings to the sides of the flask.

Shrinkage Defects in Aluminum Castings

We have sent for your information an aluminum steering wheel spider, of which we have had a number of rejections on account of the blowholes which can be noted on the upper, polished surfaces. Any suggestions you may see fit to make regarding the cause of these defects, and what must be done to avoid the same, will be greatly appreciated.

An inspection of the casting shows that one of the arms is comparatively heavy, that it is bored out and the metal appears to be sound. The hub of the wheel is cored out and the walls are comparatively thin. The heavy spoke is probably the one on which the gate is placed, because if it was not fed by a rather large sprue or a riser, it would shrink visibly, and the castings would be rejected in the foundry. It is noteworthy that in the case of the sample sent, the spoke directly in line with the heavy spoke, fails to show any of the "blowholes" visible on the two spokes at right angles to the heavy member. All of these spokes are separated by the thin hub with the result that a riser or sprue on the heavy spoke would not be able to supply metal to feed the shrinkage of the other spokes. The spoke that would have the best chance to be fed is the one that forms a continuation of the heavy spoke; the one opposite, and in the case of this sample, that spoke is free from defects. This leads us to believe the difficulty is entirely one of shrinkage; aluminum shrinks differently to brass, the eutectic appears to collect in little pools, in certain places and when it drains away to supply shrinkage at some lower point, small globular cavities are left under the congealed skin which are revealed as blowholes when the skin is cut away. We are assuming that this casting was made with the face in the cope, that the hub core was set in the drag. If the molds can be rolled over after closing, so that they are cast face down, there will be no more trouble with these cavities on the finished side. If the core print is made long and tapering so the core will wedge itself in the print, it will hang. It would be necessary to use a deeper cope than at present and this would give more pressure on the castings, which is needed. Aluminum being one-third as heavy as brass requires two-thirds higher cope to get the proper pressures. It would be advisable to try the effect of a larger sprue carried 3 inches higher first, and if this is not satisfactory it will be necessary to connect risers to each of the spokes to insure their being properly fed, when the difficulty now experienced will be overcome.

Wants High-Strength Aluminum Bronze

We are making castings of aluminum bronze containing 10 per cent aluminum and obtain 56,000 pounds per square inch tensile strength, with 40 per cent elongation. We would like to learn if it is possible to produce an alloy having 80,000 pounds tensile with 52 per cent elongation, and if so how it is made. We would also like to know whether aluminum bronze resist the action of acids in pickling tanks to such an extent that it might be considered a good acid-resisting alloy.

There is no alloy of copper and aluminum known, that in castings will possess a tensile of 80,000 pounds per square inch with over 50 per cent elongation. The tensile strength of the bronze now being made can be increased by the addition of iron to the mixture, but the elongation will be diminished. The strongest alloy of aluminum bronze so far developed contains approximately 4 per cent iron, 10 per cent aluminum and the balance copper. Aluminum bronze has a good reputation as an acid-resisting metal for use in pickling tanks.

High Speed Bushing Heavy Duty Alloys

We desire to learn which is the best alloy to use for bushings to be used in connection with machinery running at high speed and under heavy load. We would like to know if a hard phosphor bronze or a highly leaded bronze is the

best. Our suggestion is a bronze of the following formula: Copper, 84 per cent; tin, 10 per cent; lead, 3 per cent; zinc, 3 per cent.

If the bushings are to be carefully fitted to the shaft that is to run in them, a hard bronze would be more suitable than a leaded bronze, provided also that it can be properly lubricated. Under such circumstances a heat-treated aluminum bronze carrying 10.50 per cent aluminum has given excellent service. If the bearing is poorly fitted, and as a consequence has to "conform" to the shaft, a leaded alloy should be used; a suitable one being Ex. B metal as follows: Copper, 76.80 per cent; tin, 8.00 per cent; lead, 15.00 per cent, and phosphorus 0.2 per cent. For a well fitted bearing the mixture suggested in the query would be a good one to use. Elephant bronze would also be suitable; the alloy follows: Copper, 85 per cent; phosphor copper, 0.50 per cent; tin, 10.50 per cent; zinc, 2.50 per cent, and lead, 1.50 per cent.

Too Close a Sand Causes Blow Holes

We are casting housings for automobile starters and are experiencing difficulty with blow holes. Will you kindly inform us if the use of a mixture of Sandusky sand with Newport sand would prevent this blowing. We use No. 12 aluminum.

If the blowing is due to the use of too fine a sand, an admixture of a more open grade will remedy the trouble. Sand used for molds for aluminum should be fine and yet open in texture so the gases can pass through the mold. If the gas is unable to pass through the sand, it will pass through the aluminum, and it will do this much more readily than in the case of the heavier metals.

If when the sand is dried water soaks into it quickly, it is free venting, but if the water rolls down the slope and runs away from the sand, the latter is too close and had better be discarded. If the sand is free venting and still causes blown castings, then it is either being worked too damp, or the molds are being rammed too hard. A combination of clayey sand, hard ramming and too much water will always cause trouble in molding operations.

Charging Britannia Metal

We are making castings of britannia metal of the following composition: Tin, 88.90 per cent; copper, 3.70 per cent, and antimony, 7.40 per cent. We melt in a plumbago crucible and would like to be advised as to the best manner of charging the various metals into the crucible. Also, what flux should be used?

The best way to make the alloy would be by the use of a hardener, which is first produced as follows: Melt 37 pounds of copper, in the crucible, or any part of 37 pounds according to the size of the crucible, but it must be remembered that the same divisor used for the copper must be applied to the antimony also. Suppose the crucible will hold 250 pounds of metal. Melt 37 pounds of copper and when thoroughly liquid commence adding 74 pounds of antimony. The latter must be added to the copper gradually, with intervals of waiting as necessary to permit the metal to regain its lost heat. When the antimony is all added, there will be 111 pounds of molten metal in the crucible. To this add an equal amount of tin, or 111 pounds, then pour the hardener into ingots by dipping it out with a ladle. The britannia is then conveniently made by simply melting together 77.80 pounds of tin, with 22.20 pounds of hardener. By this method, a better alloy will be produced. The various metals will be alloyed better, as they will be more intimately mixed. For a flux use tallow or tallow and rosin, scattered on the molten surface. This will reduce the dross to a powder which may be skimmed off without great loss of metal.

Recommends Types of Melting Furnaces

We occasionally make a little brass work and have tried to melt the same on a forge, using a crucible and scrap brass. We desire to know if we can improve upon this practice by rigging up a little cupola and melting the brass with coke in the same manner as we melt cast iron? Also, we sometimes make steel castings, but not in quantity to justify the expense of putting in an electric furnace. Can steel be melted satisfactorily in a crucible? We would turn out about 4 tons a month.

Melting brass on a forge is very unsatisfactory and should be abandoned. A regular brass melting furnace of a size suitable to care for the work should be installed. Whether it is fired with oil, gas or coke will depend upon which fuel is most convenient. It will not pay to attempt to build a brass furnace unless the details of construction are thoroughly understood, as it will cost more to build than to purchase one. While brass can be melted in a cupola, this method should never be adopted except under stress of circumstances, as in the case of an extremely large casting. It is not feasible to melt brass in contact with sulphur containing fuels, because it will cause holes to appear in the castings. Steel castings can be commercially produced from crucibles, and have been for many years, but the electric furnace is now preferred. An oil-fired furnace of the Noble type, much used in Milwaukee, would be suitable for melting the steel in crucibles. This furnace consists of a rectangular hole in the ground lined with firebrick and connected to a stack. It is covered with bungs of firebrick. The pan type of burner is generally used.

Aluminum Alloys for Pressure Work

We have experienced considerable difficulty in making aluminum castings to be used as floats in a machine used in making distilled water. The castings are 6 inches long and 3 inches in diameter, with walls ⅜-inch thick. They are cylindrical in form with one end closed, and a ½-inch hole through the center of the other, and they weigh 13 ounces. The difficulty we experience is due to leakage, as the castings are subjected to 4 pounds per square inch water pressure. We have used practically pure aluminum, also auto crank case scrap, but all the floats leaked, as the heavy water pressure appeared to force the liquid through the walls of the castings. It has been suggested that we add antimony to harden the aluminum and close the pores. Any suggestion would be appreciated.

Both pure aluminum and scrap aluminum are unsuited as material from which to make castings to withstand pressures. Pure aluminum, meaning by this term commercial aluminum, is too open in character to be used for this purpose and scrap aluminum is too uncertain in composition. For pressure castings it is necessary to use an alloy high in copper, as the copper hardens the aluminum and closes its pores. Antimony is not suitable for this purpose, for while it hardens copper, it does not act the same with aluminum, it is in fact an undesirable addition to the light metal. For pressure castings of aluminum an alloy of copper 12 per cent; aluminum 88 per cent finds considerable application. Owing to the high percentage of copper it is slightly heavier than the regular No. 12 alloy containing 8 per cent of copper, and as weight appears to be a factor with these castings, it would be well to try an alloy of copper, 2 per cent; magnesium, 2 per cent, and aluminum 96 per cent, which has proved successful as a pressure resisting aluminum alloy. It has the advantage of being of low specific gravity and would appear to be suitable.

Electrical Melting of Alloys—VI

Electric Furnaces of the Indirect-Arc Type Have Proved Successful for Melting Zinc Bearing Alloys When the Bath Is Agitated to Prevent Local Heating

BY H. W. GILLETT

LOCAL overheating of the charge immediately under the arc limits the economical use of direct-arc electric furnaces to alloys containing not much over 5 per cent zinc, as was shown in previous articles. Likewise a similar, though less intense, overheating occurs under the arc of an indirect-arc furnace. This limits the economical use of the indirect-arc furnace to alloys with not much over 15 per cent zinc.

Therefore, the types of electric furnace best suited to melting steel fail to solve the problem of melting yellow brass. The cause of this failure lies in the fact that to get good thermal efficiency heat must be supplied rapidly, so rapidly, in fact, that conduction through the metal will not carry it away fast enough to prevent local overheating near such a concentrated and high-temperature source of heat as the electric arc.

The trouble from local overheating could be overcome by adopting a different type of furnace to cut down the rate of heat input, or to supply a less concentrated heat. If it is decided to employ the arc furnace, the rate at which heat may be distributed through the charge must be increased without decreasing the rate of heat input. Several workers were developing brass furnaces of the non-arcing type and, in order that all types might be tried, the bureau of mines took up the study of the arc furnace.

Distributing the Heat

The logical way to distribute the heat through the charge is to stir the metal. This should overcome the surface overheating due to hotter, and hence lighter, metal staying on top of the melt. It is obviously easier to do this in an indirect-arc than in a direct-arc type furnace where the arc is nearer to the metal. Since complicated construction in the hot zone of an electric furnace means a furnace of low reliability, stirrers in the melt are useless. The logical method for the avoidance of local overheating seemed to be to stir by moving the whole furnace, since such stirring can be done by means located wholly outside the furnace.

Stassano's first indirect-arc furnaces (*) for melting steel were designed to give some agitation of the bath. The furnace had its upright axis at an angle with the vertical, so that by turning it around mechanically, a gyratory motion was set up. The arrangement of the furnace is shown in Fig. 1. Of the later Stassano installations some were made stationary and some movable.

The Weeks (**) furnace is another indirect-arc furnace so mounted as to be capable of motion. It was designed

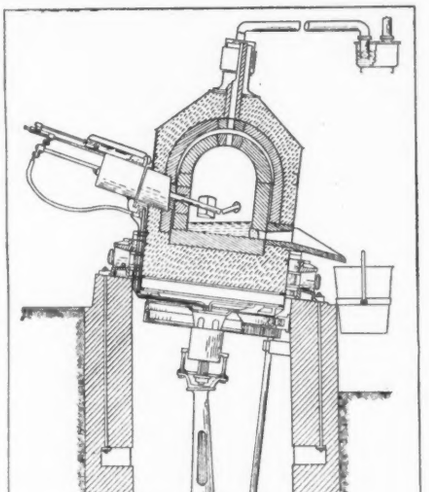


FIG. 1—THE OLDER TYPE OF STASSANO FURNACE HAS A GYRATORY MOTION WHEN TURNED

for zinc smelting and was tested by Hansen (***) at the works of the General Electric Co., Schenectady, N. Y., in 1910. This furnace, shown in Fig. 2, is a cylinder laid on its side, with two electrodes for single-phase current, one extending through each end. The electrodes are held by supports separate from the furnace shell and not moving with the shell. The mounting of the furnace on rollers was evidently planned to allow turning the furnace over from time to time so as to interchange roof and hearth to equalize wear on the refractories, rather than to keep it constantly in motion. Two heats of copper were made in the furnace, operated stationary, but no brass was melted. The General Electric Co. then tried a stationary Stassano furnace for brass. This was soon abandoned and a different type of furnace was adopted.

No trials of brass melting in the moving form of Stassano furnace have been recorded. Since none were made in the Weeks furnace it appears that the idea of avoiding surface overheating through stirring a melt of brass by moving an indirect-arc furnace while running, originated with the bureau of mines. The first experimental test of this process was made on Aug. 25, 1915, in the little 35-kilowatt, 125-pound rocking furnace shown in Fig. 3. This furnace was designed to rock continually while melting. The electrodes were supported by the end of the furnace and moved with it.

The furnace was rocked back and forth by hand as soon as the charge started to melt. The motion at first was through a small angle, then through a gradually increasing one as the charge melted, till, when all the metal was melted the furnace was rocked as far each way as was possible without allowing the metal to run up against the charging door.

Results With Red Brass

The idea of stirring the metal worked out nicely. If the furnace was not rocked, it acted just as other stationary indirect-arc furnaces act, generating a high pressure of zinc vapor when yellow brass was melted, and showing a high metal loss. When it was rocked properly, local overheating of the surface was avoided by the stirring, the furnace could be kept tight, and the metal losses were low. Yellow brass ingot was melted with 1 per cent loss. Manganese bronze chips that gave 7.2 per cent net loss in an oil-fired crucible, gave 3 per cent net loss in the rocking furnace. Ingot containing 25 per cent zinc gave 0.5 per cent loss, red brass chips 1 per cent, red brass scrap 0.5 per cent, red brass ingot 0.2 per cent.

The furnace ran on red brass, poured at about 1200 degrees Cent. at the rate of 375 kilowatt hours per ton for 10-hour operation, and 325 for 24-

*Stassano, E., U. S. Patent 799105; Application of the Electric Furnace to Siderurgy. Trans. Am. Electrochem. Soc., Vol. 15, 1909, p. 70.

**Weeks, C. A., U. S. Patent 949511.

***Hansen, C. A., Electric Melting of Copper and Brass. Trans. Am. Inst. Metals, Vol. 6, 1912, p. 110.

hour operation. The consumption of graphite electrodes was about 3 pounds per ton. Not only was the metal loss practically as low as it was in electric crucible lift-out furnaces, but the power consumption was extraordinarly low for so small a furnace. Washing the roof portion with the metal absorbs the heat that in stationary furnaces is stored in the roof at a temperature higher than that of the bath. Leakage of heat from the roof is thus decreased. Internal heating of a charge is the most efficient way to heat it, and the rocking furnace might be said to accomplish the equivalent of internal heating, since intermittently the charge is between the source of heat and practically all the furnace wall. It appeared that this type offered one practical solution of the problem of finding an electric furnace that would operate on yellow brass as well as on alloys low in zinc. Through the cooperation of the Detroit Edison Co., Detroit, the bureau of mines was able to carry the experiment work further. This was done in a 1300-pound 200-kilowatt rocking furnace installed at the plant of the Michigan Smelting & Refining Co., Detroit. This furnace was started on May 9, 1917. It was tilted endwise, as well as rocked, in order to secure the maximum stirring. The experiments have been described.*

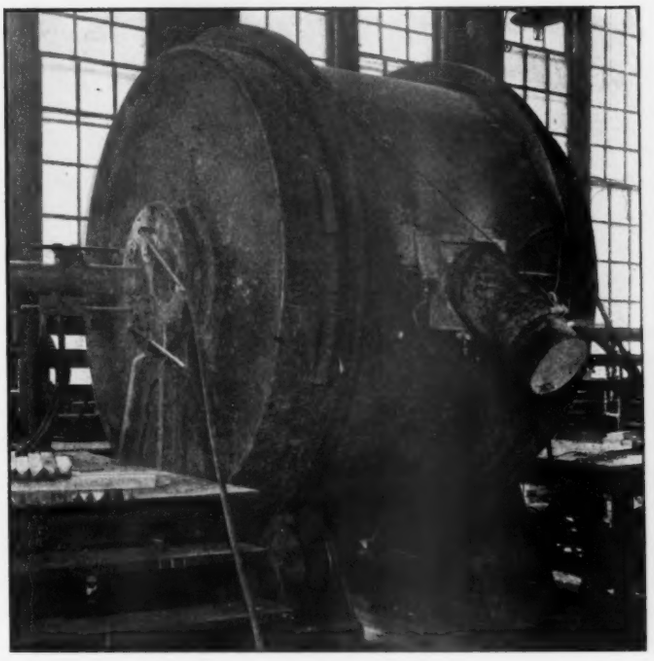


FIG. 2—THE WEEKS ZINC FURNACE WAS THE PIONEER TO ADOPT THE ROTATING PRINCIPLE

Low Melting Loss

The tests covered alloys containing from 0 to 30 per cent zinc and 0 to 25 per cent lead. The metal loss on 100 tons of different alloys averaged 1.8 per cent less than that on the identical amounts of the same alloys melted in coke-fired crucibles in the same plant. The alloys were found to be thoroughly mixed by the stirring action of the furnace. The 1300-pound furnace produced 3 to 4 tons of red brass, poured at 1150 degrees Cent., with a power consumption of 335 kilowatt hours per ton, on one shift of 10 hours' operation. It melted 9 tons at 260 kilowatt hours per ton on a 24-hour operation. Both of these sets of figures are based on operation under the handicap of foundry delays in pouring, waiting for cranes, and the other usual causes.

The rocking furnace was patened(**) and the patents assigned to the secretary of the interior as trustee. Free licenses to operate under the patents are granted on the recommendation of the bureau of mines. A license was taken out by the Detroit Electric Furnace Co., Detroit, which has incorporated in its design the improvements that were indicated by the tests of the experimental furnace.

The Detroit rocking furnace has been described by St. John (*) and is

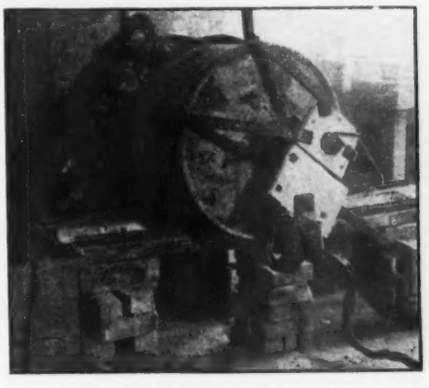


FIG. 3—A SMALL ROCKING FURNACE WAS USED FOR EXPERIMENTAL PURPOSES

shown in Figs. 5 and 6, which show the general construction of the furnace. It is a cylindrical drum, lying on its side, but tilted a little in the supporting gear-rings to cause a greater stirring of the charge. The electrodes enter from the ends and are supported and adjusted by holders and slides attached to the ends of the furnace. Flexible leads and water hose allow the electrodes and water-cooled holders to be moved back and forth to control the arc, and to be drawn back out of harm's way while charging. The door which was made rather large to allow rapid charging, is taken completely off the furnace by a small jib crane before charging. It was decided that an attached door either would be in the way or would radiate heat to the discomfort of the operator while charging. The pouring spout is located beneath the door. The door need not be removed during pouring. Since the furnace can be rocked to any desired position the orifice can be turned uppermost for mechanical charging from a charging bucket. The furnace is rocked by a small electric motor and the reversal of the motor is automatically controlled by electrical contact. The change in the angle of rocking, that is, the time interval at which the motor is reversed, is controlled by the position at which a pair of arms are set on the rocking controller, shown nearest the switchboard in Fig. 5.

Special Lining

The furnace is lined with a layer of corundite brick, a very refractory brick, higher in alumina (Al_2O_3) than ordinary firebrick. Next to this is an intermediate layer of less refractory firebrick chosen for its heat insulating properties. The outer layer, next the shell, is of brick made from infusorial earth. The 1-ton furnace uses graphite electrodes 4 inches in diameter, though some installations are now being made with 5-inch electrodes. It takes 300 kilowatt seconds, single-phase, at about 120 volts, and the furnace and transformer together have a power factor of about 85.

The first heat was taken from a Detroit rocking furnace on Aug. 27, 1918, and in the next 19 months 30 other furnaces of this make went into operation and 15 were being installed. About a third of these furnaces are being operated steadily on yellow brass, the rest being in plants that operate them on various alloys, usually both red and yellow brass.

As is the case with all other furnaces, the output and the power consumption per ton vary greatly with the continuity of operation and the speed with which charging and pouring is done. The accompanying table summarizes

*Gillett, H. W., and Rhoads, A. E., Melting Brass in a Rocking Electric Furnace, Bull. 171, U. S. Bur. Mines, 1918. Rocking Electric Brass Furnace, Jour. Ind. Eng. Chem., Vol. 10, 1918, p. 459; Foundry, Vol. 46, 1918, p. 314; Brass World, Vol. 14, 1918, p. 217; Met. & Chem. Eng., Vol. 18, 1918, p. 583.

**Gillett, H. W., and Lohr, J. M., U. S. Patent 1201224. Gillett, H. W., U. S. Patent 1201225.

*St. John, H. M., The Detroit Rocking Furnace for Melting Brass and Bronze, Metal Ind., Vol. 17, 1919, p. 320.

the performance of the 1-ton furnace under various conditions.

The power consumption per ton of metal, mostly red brass, at the Denny-Rine Co., Chicago, for the period Feb. 1 to Sept. 1, 1919, was 290 kilowatt hours. The furnaces were operated on both a 24-hour and a 10-hour basis during this time. The metal was poured into ingots, and the operation of the furnace was thus not subject to such delays as waiting for molds. Rapid charging and pouring were done. Even better figures than those given in the table are reported by St. John. (*) The rocking furnaces at the Michigan Smelting & Refining Co. averaged 364 kilowatt hours per ton on 6000 tons of red brass and bronze.

In one month's operation on red brass in a jobbing shop the power consumption on 200 tons of red brass averaged about 425 kilowatt hours per ton. During this run the shop was not operated at full capacity and consequently the furnace was not forced. Little attention was paid to speed in pouring and charging, so the furnace averaged as long on idle time between heats as the time required for the heat itself. Half the output was melted at around 375 kilowatt hours per ton, the higher figure for the total tonnage being due to badly delayed operation while melting the other half.

Low metal losses are obtained with this furnace even on alloys high in zinc as the table shows. One interesting point is that instead of waiting till the heat is almost ready to be poured before adding zinc, even on 60/40 brass made from new metals, the zinc can be added at the start of the heat, with less delay and no greater metal loss than when it is added at the end.

In a test on some 30 heats of red brass at the Fort Motor Car Co., Detroit, half of which were melted in an open-flame oil furnace and half in the rocking furnace, the charges to both furnaces having the same composition, determinations of zinc and lead showed an average of 2.53 per cent zinc and 1.54 per cent lead in metal from the open-flame furnace, and 4.05 per cent zinc and 1.65 per cent lead in metal from the rocking furnace. The time saving was found in a metal loss comparison, made by weighing charge and product, at another plant melting red brass in a rocking furnace and in a different type of open-flame furnace.

Metallurgist Reports

The metallurgist on one rolling mill states that no greater difference in analysis has been found in the first and the last metal from a heat of 60/40 brass poured from the rocking furnace than might be expected from duplicate analyses of the same sample. This indicates that the metal is thoroughly mixed. The degree of thoroughness of mixing, is also indicated by the analysis of the first ingot poured from the first ladle of a heat of highly leaded bearing bronze, which showed 25.49 per cent lead, and the analysis of the last ingot poured from the last ladle, which showed 25.25 per cent lead. The quality of the product has been found to be the same as that from coke-fired crucibles. The furnace can be drained thoroughly so that successive heats of different compositions can be made.

Of course, if the furnace has been used on a series of runs on 60/40 brass, for example, the lining will be impregnated with condensed zinc, and if the next heat were to be of pure copper for high conductivity castings, some of the zinc might be vaporized again and driven into the copper. In changing from one alloy to a widely different alloy which cannot tolerate some of the components of the first, any hearth furnace should be given a suitable wash heat. However, all common red and yellow mixtures can be handled one after the other without serious contamination.

While heat is stored in the walls, the heat stored when the metal is melted is at no higher temperature than is the charge itself. Therefore, there is no tendency for the temperature of the charge to rise after the current is shut off, as there is in furnaces whose roofs store much heat at a higher temperature than the charge. This allows a closer temperature control than is possible in any other type furnace save the induction furnace.

On single-shift operation the furnace is usually preheated half an hour before charging if the furnace has not been operated the previous day, but it is not necessary to do any night heating. The time and power used in preheating are, of course, included in the figures given in the table, and these figures are based on the power as metered on the primary side of the transformer.

The furnace gives good working conditions, can be closed tight to prevent

*St. John, H. M., Melting Nonferrous Metals and their Alloys in the Electric Furnace, Chem. & Met. Eng., Vol. 22, 1920, p. 148.

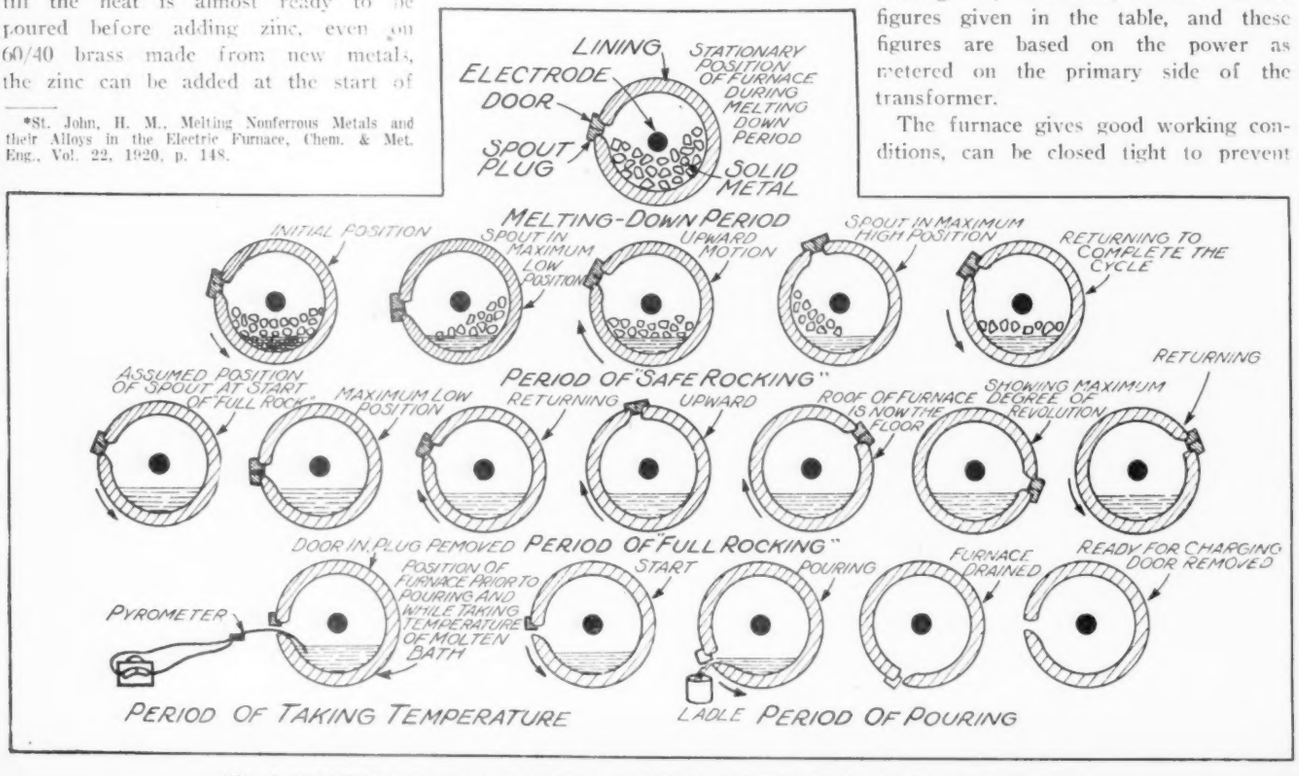


FIG. 4—DIAGRAMS SHOW POSITIONS OF THE FURNACE DURING MELTING, ROCKING AND POURING

DECIMAL PARTS OF A GROSS TON

To reduce railroad weights in pounds to tons and decimal fractions this table saves much computation. Assuming a carload of pig iron, scrap or coke weighs 90,680 pounds, the table in Data Sheet No. 331 shows that 40 tons is 89,600 pounds, leaving a remainder of 1080 pounds, which the following table indicates is .4821 of a ton. The total carload therefore is 40.4821 tons. Multiplication by the cost per ton gives the exact cost of the carload and multiplication by the freight rate gives the exact charges.

TABLE OF DECIMAL PARTS OF A GROSS TON

Pounds	Decimal	Pounds	Decimal	Pounds	Decimal	Pounds	Decimal
1	0004	160	0714	410	1830	660	2946
2	0009	170	0759	420	1875	670	2991
3	0013	180	0804	430	1920	680	3036
4	0018	190	0848	440	1964	690	3080
5	0022	200	0893	450	2009	700	3125
6	0027	210	0938	460	2054	710	3170
7	0031	220	0982	470	2098	720	3214
8	0036	230	1027	480	2143	730	3259
9	0040	240	1071	490	2188	740	3304
10	0045	250	1116	500	2232	750	3348
15	0067	260	1161	510	2277	760	3393
20	0089	270	1205	520	2321	770	3438
30	0134	280	1250	530	2366	780	3482
40	0179	290	1295	540	2411	790	3527
50	0223	300	1339	550	2455	800	3571
60	0268	310	1384	560	2500	810	3616
70	0313	320	1429	570	2545	820	3661
80	0357	330	1473	580	2589	830	3705
90	0402	340	1518	590	2634	840	3750
100	0446	350	1563	600	2679	850	3795
110	0491	360	1607	610	2723	860	3839
120	0536	370	1652	620	2768	870	3884
130	0580	380	1696	630	2813	880	3929
140	0625	390	1741	640	2857	890	3973
150	0670	400	1786	650	2902	900	4018

(*Concluded on Data Sheet No.* 334)

Note—This sheet may be cut into two sections, 8 x 7 inches, and may be readily bound in note book form.

DECIMAL PARTS OF A GROSS TON

(*Concluded from Data Sheet No.* 333)

TABLE OF DECIMAL PARTS OF A GROSS TON

Pounds	Decimal	Pounds	Decimal	Pounds	Decimal	Pounds	Decimal
910	4063	1260	5625	1610	7188	1960	8750
920	4107	1270	5670	1620	7232	1970	8795
930	4152	1280	5714	1630	7277	1980	8839
940	4196	1290	5759	1640	7321	1990	8884
950	4241	1300	5804	1650	7366	2000	8929
960	4286	1310	5848	1660	7411	2010	8973
970	4330	1320	5893	1670	7455	2020	9018
980	4375	1330	5938	1680	7500	2030	9063
990	4420	1340	5982	1690	7545	2040	9107
1000	4464	1350	6027	1700	7589	2050	9152
1010	4509	1360	6071	1710	7634	2060	9196
1020	4554	1370	6116	1720	7679	2070	9241
1030	4598	1380	6161	1730	7723	2080	9286
1040	4643	1390	6205	1740	7768	2090	9330
1050	4688	1400	6250	1750	7813	2100	9675
1060	4732	1410	6295	1760	7857	2110	9420
1070	4777	1420	6339	1770	7902	2120	9464
1080	4821	1430	6384	1780	7946	2130	9509
1090	4866	1440	6429	1790	7991	2140	9554
1100	4911	1450	6473	1800	8036	2150	9598
1110	4955	1460	6518	1810	8080	2160	9643
1120	5000	1470	6553	1820	8125	2170	9688
1130	5045	1480	6607	1830	8170	2175	9710
1140	5089	1490	6652	1840	8214	2180	9732
1150	5134	1500	6696	1850	8259	2185	9754
1160	5179	1510	6741	1860	8304	2190	9777
1170	5223	1520	6786	1870	8348	2195	9799
1180	5268	1530	6830	1880	8393	2200	9821
1190	5313	1540	6875	1890	8438	2205	9844
1200	5357	1550	6930	1900	8482	2210	9866
1210	5402	1560	6964	1910	8527	2215	9888
1220	5446	1570	7009	1920	8571	2220	9911
1230	5491	1580	7054	1930	8616	2225	9933
1240	5536	1590	7098	1940	8661	2230	9955
1250	5580	1600	7143	1950	8705	2235	9978

THE FOUNDRY DATA SHEET, MAY 15, 1920
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Summary of Performance of 1-ton Detroit Electric Furnace at Various Plants

Alloy	Firm	Number tons on which figures are based	Hours furnace operated per day	Output per day tons	KWH per ton	Pounds electrodes per ton	Per cent metal loss, including nonmetallic material in charge Gross	Net	Remarks
Red brass	Michigan Smelting & Refining Co.	178	20	9	310	...	3.5	0.65	Much oily borings in charge
Phosphor bronze	Aluminum Manufactures, Inc.	42	9	4	330	...	....	....	Metal poured at 1250° C. Poured in 8 ladles per heat.
Red brass	Sherwood Brass Co.	92	9	4	340	4	....	....	
Red Brass 10% zinc	Denny-Rine Co.	(a)	24	16	270	2¼	3.6	0.70	Zinc added as oily yellow borings, 1600-lb. heats.
Pure copper	Wheeler Condenser Co.	37	24	9	360	...	0.34	....	Line voltage, low—power input too low making output low and power consumption high
All red brass borings	Denny-Rine Co.	(b)	24	21½	240	2¼	....	....	2200-lb. heats
Red brass	Gen. Al. and Brass Mfg. Co.	34	9½	6½	290	3½	0.44	....	Metal poured at 1140° C.
Brass of 18% zinc	Michigan Lubricator Co.	37	9	5	315	3¼	2.5	0.9	
Red brass	White & Bro.	97	10	..	330	...	....	....	
60/40	C. B. Bohn Fdy.	14	6	4	325	...	1.66	1.03	
60/40	Detroit Copper & Brass Rolling Mills	34	9	6	275	...	....	0.9	
60/40	Detroit Copper & Brass Rolling Mills	(a)	16	10	250	3¾	....	under 1%	
60/40	Cleveland Brass and Copper Rolling Mills	33	8	6	220	2½	1.0	....	
60/40	Chase Metal Works	500(b)	16	14	240	...	....	1.02	
60/40	Chase Metal Works	170(b)	8	6½	280	...	....	....	
Manganese bronze	Oregon Brass Works	15	6 to 8	3½ to 4	270	...	2.84	....	

(a) Average operation. (b) Test operation.

egress of zinc fumes, and is cool in operation. In one plant using both fuel-fired and rocking furnaces, the rocking furnaces were kept operating on some hot summer days when the operators of the fuel-fired furnaces would not work on those furnaces. One plant's figures show the labor cost per ton on the rocking furnace to be between 50 and 60 per cent of that on coke-fired crucibles. Another plant figures that its total melting costs have been cut 50 per cent by replacing coke-fired crucible furnaces by the rocking electric furnace.

Too little data is available on the smaller sizes to establish fully their possibilities and limitations. The first furnaces of the 1000-pound and 500-pound sizes have but recently been installed, and they have not been operated as yet up to full capacity.

The 500-pound furnace at the Hills-McCanna Co. operated to give four heats, or 1 ton, in eight hours uses about 385 kilowatt hour per ton on red brass. On 14 heats, the furnace only being operated two or three heats on most of the days, the power consumption on red brass was about 425 kilowatt hours per ton. The last heats of the day indicate that the furnace would melt at about 300 kilowatt hour per ton on 24-hour operation.

The 1000-pound furnace, at the Oregon Brass Works, operated to average about five heats, or 2½ tons in eight hours, gave an average power consumption of 350 kilowatt hours per ton, on 60 heats of red brass, gun metal and leaded bronze. The last heats of the day indicate that on 24-hour operation it would run at about 250 kilowatt hours per ton.

On the score of metallurgical fitness, metal losses and general versatility, this type of furnace is a distinct advance over the direct-arc type. Its reduced labor cost and metal losses, its elimination of crucibles, and its high thermal efficiency, make it show savings over fuel-fired furnaces. Its thermal efficiency is better, under the same conditions of operation than that of any other type in use, save the induction furnace. This might be expected from a theoretical point, since the induction furnace generates heat in the metal itself, and the rocking type shows the next closest approach to internal heating.

Because the furnace must be constructed to allow rocking, it is im-

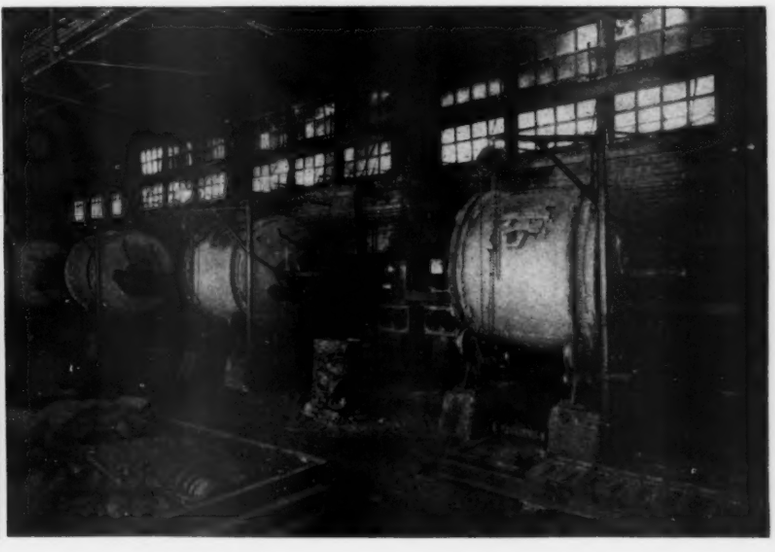


FIG. 5—A 1-TON DETROIT ROCKING FURNACE WITH JIB CRANE FOR HANDLING THE LADLE FIG. 6—THE SUCCESS OF THE DETROIT FURNACE IS SHOWN BY A NUMBER OF INSTALLATIONS IN THE SAME FOUNDRY

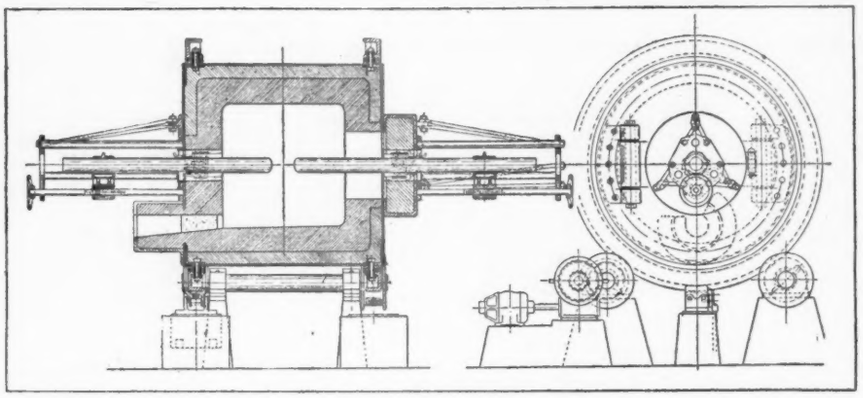


FIG. 7—GENERAL ASSEMBLY OF THE DETROIT ROCKING ELECTRIC BRASS FURNACE

possible to put on a spare roof when the roof portion of the lining fails, as is done in both stationary direct and indirect arc furnaces. The lining is of course cooled as the charge washes it, so that its temperature at the end of a heat is not above the pouring temperature of the charge, and this protects the lining. If the furnace is held stationary when operating on bronze where rocking is not so essential to prevent loss, the roof portion of the lining may be badly damaged in a few heats. This indicates that the rocking furnace should be rocked, even on bronze.

There is some tendency to erosion by the moving charge, but this is not marked. Slight repairs to the refractories may be made by turning the furnace so that the damaged part is at the bottom, then patching and heating the furnace to set the patch while it is held in place by gravity.

The lining life is usually about 350 heats, although 600 heats are often obtained, and 700 to 800 heats from a lining are not uncommon figures. Usually only the inner course, that of corundite brick, needs replacement. The brick for this on the 1-ton size costs about $100. Labor for relining is said to cost about $50.

Care is of course necessary to keep the rocking control mechanism, gears, and bearings cleaned and lubricated, but, with reasonably careful treatment, the reliability of the furnace is good. Some of the first furnaces had trouble with gears and bearings, but experience brought improvements in design and in materials used which overcame this.

Besides inability to quickly put on a new roof, there are some other drawbacks to this type. If the furnace is rocked too far before the charge is sufficiently melted, ingots or heavy scrap may be carried up so high that they fall on the electrodes and break them. This danger will be made apparent by Fig. 4. That this danger can be overcome is shown by the low electrode consumption listed in the table.

In operating on alloys high in zinc some zinc usually condenses on the electrodes within the furnace wall. If this is allowed to freeze, it will cause the electrode to bind. Therefore, on single-shift operation on yellow brass, the electrodes should be pulled out of the walls and cleaned at night. The water cooling about the electrode should be so adjusted as to allow the electrode to run hot enough to keep the condensed zinc in a molten condition.

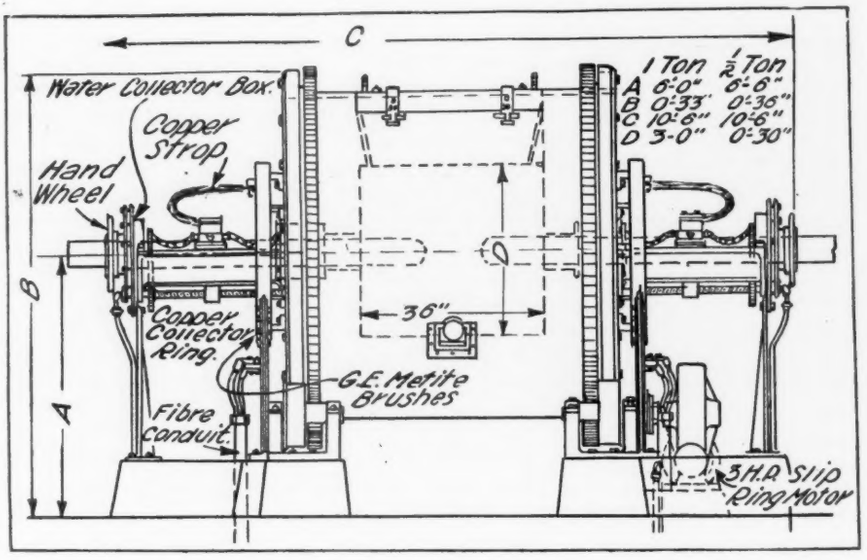


FIG. 9—DESIGN OF THE ROTATING ELECTRIC BRASS FURNACE MADE BY THE AMERICAN METALLURGICAL CORP.

The furnace has another difficulty common to arc furnaces. When the charge contains a great proportion of oily borings the oil must be distilled out quite completely before starting the arc, since oil vapor is a nonconductor of electricity and the arc will not hold steadily in such a vapor. Up to 25 pounds of oil in a 1-ton charge will burn out at once if the oily borings are charged into the hot furnace before the rest of the charge. This is also advisable in that they serve as a cushion over the hearth when the heavier material is dumped in. A charge consisting entirely of borings with 4 per cent, or 80 pounds of oil, involves a few minutes delay to allow the oil to be driven off.

The most serious drawback is the fact that the 1-ton furnace takes a 300 kilowatt single-phase load, which makes it unsuited for very small gen-

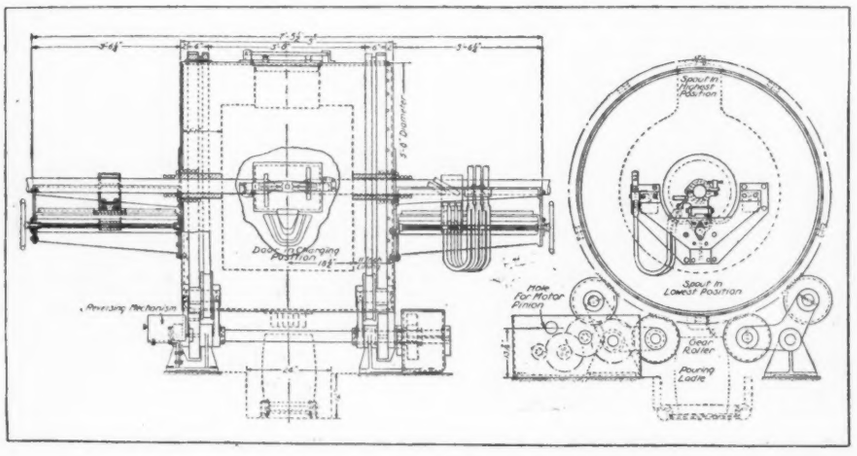


FIG. 8—DETAILS OF THE BOOTH ELECTRIC ROTATING BRASS FURNACE

erating stations or low capacity transmission lines. Of course, two or three sets of arcs, each on a phase, could be used, but such a design would complicate the furnace. By the use of suitable reactance, surges are minimized without bringing the power factor below about 85, and the furnaces have been an acceptable load to the central stations to whose lines they are connected. Smelting and refining plants offer a field for a furnace of more than a ton capacity, and a large two-phase furnace is being built for such use.

Forty 1-ton, two 1000-pound and three 500-pound Detroit rocking furnaces have been installed or ordered for melting brass. The prices f.o.b. Detroit of the Detroit Rocking furnace, including transformers, motor, switchboard, meters and all other equipment were quoted on Feb. 24, 1920, as follows: 500-pound size, $6500; 1000-pound size, $8500; 1-ton size, $11,500. Automatic electrode control is supplied at about $750 extra. The 1-ton size, in a nose-tilting type, is quoted at $12,750.

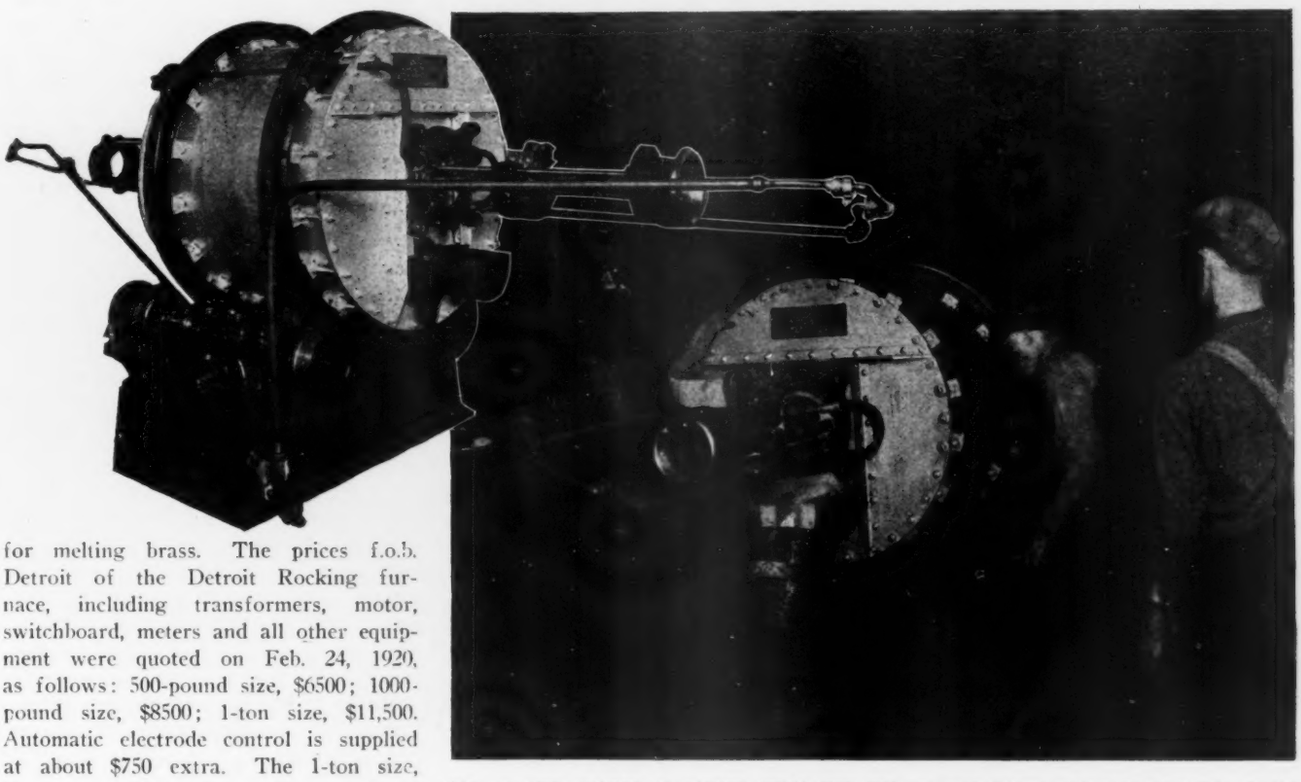


FIG. 10—THE CHARGE IS POURED FROM THE END IN THE BOOTH ELECTRIC ROTATING BRASS FURNACE, THE TAPPING HOLE BEING DIRECTLY UNDER THE ELECTRODE

Two other furnace makers have recently put out furnaces of this type. Their points of difference are shown in Figs. 7, 8 and 9, which show respectively the design of the Detroit rocking furnace, the Booth rotating furnace, and the rocking furnaces made by the American Metallurgical Corp., Philadelphia. The 250-pound Booth furnace is also shown in Fig. 10.

The Detroit furnace charges on the side, rocks back and forth, and has its leads solidly fastened to the electrode holders, the cables swinging as the furnace rocks. (*) The Booth furnace, made by the Booth Electric Furnace Co., Chicago, has no opening on the circumference. It is charged through a door at one end which also carries the electrode and its support. It has a tap hole at the other end, carries current to the furnace by sliding contacts, and rotates the furnace instead of rocking it. The first heat was made in a Booth furnace on May 17, 1919. The furnace was of 250 pounds capacity and was installed at Leitelt Bros., Chicago. Early a 500-pound Booth furnace went into operation at the plant of the Cleveland Brass Mfg. Co., Cleveland. No other installations are known to the writer to have been completed on March 1, 1920, but it is stated (**) that 20 furnaces have been sold.

The furnace made by the American Metallurgical Corp. is said (***) to be patterned after the Weeks zinc furnace, but instead of the stationary electrodes supported outside the furnace, the supports are attached to the furnace shell and move with it. The furnace is designed to be kept in motion during melting, and while termed a *rotating* furnace, it has "a system of automatic switches by which the drum can be rotated to any percentage of the circumference at the will of the operator." The charging door is on the side, and hence a rocking motion rather than complete rotation seems to be contemplated. The current, as in the Booth furnace, is carried on sliding contacts.

No furnace of this make was yet in operation on March, 1920, but one of 1000-pound capacity, was being installed at the York Hardware & Brass Co., York, Pa.

Sliding contacts and complete rotation were both considered in the design of the rocking furnace by the bureau of mines. The first was not considered desirable, for while a current of 500 to 1000 amperes taken by a small furnace might readily be so carried, the carrying on a sliding contact of the 2000 to 3000 amperes needed by a 1-ton furnace seemed less reliable than flexible leads with solidly fastened contacts. It may be granted the furnace would look better without swinging cables, but it would not be likely to act better. Trouble would be experienced amid the dust and dirt of a foundry in keeping clean the sliding contacts.

In his later moving furnaces Stassano went to great pains to provide a construction which would replace the earlier sliding contacts by permanent solid contacts. (*)

Complete rotation seems unpromising, because rocking too far in a large rocking furnace before the charge is

*Booth, C. H., The Booth Electric rotating brass furnace, Booth, W. K., U. S. Pat. 1332795, March 2, 1920. Iron Age, Vol. 103, 1919, p. 1699. Metal Ind., Vol. 17, 1919, p. 317. Chem. Met. Eng., Vol. 21, 1919, p. 637, Vol. 22, 1920, p. 136. Electrical World, Vol. 74, 1919, p. 1107.

**Metal Industry, N. Y., Vol. 18, 1920, p. 107.

***Ryan, F. J., Week's Electric Rotating Furnace as Applied to the Brass Industry, Metal. Ind., Vol. 17, 1919, p. 519.

**Metal Industry, N. Y., Vol. 18, 1920, p. 107. 1105559. Schmelz, E. M., A New Electric Steel Casting Plant, Met. & Chem. Eng., Vol. 11, 1913, p. 709.

sufficiently melted has in the writer's experience been synonymous with broken electrodes and much trouble on a normal charge. Charges of all borings, where the change is not in large enough pieces to break the electrodes when they fall on them, do not require as much care while rocking the furnace. The 125-pound laboratory rocking furnace did not require much care even when ingots were melted.

If rocking or rotating is delayed on red brass till danger of electrode breakage is past, the lining will have more severe punishment, as in such a proceeding it is cooled by the melt for a lesser time. The writer's experience on yellow brass has been that delaying rocking till the charge is sufficiently melted to allow full rotation fails to stir the charge soon enough to avoid surface overheating. This causes such excess zinc pressure that the furnace will not stay closed, and large metal loss is experienced.

Fortunately a 1-ton Booth furnace is to be installed at the Michigan Smelting & Refining Co., for comparison with the four Detroit rocking furnaces there, so a decisive answer to the question will ultimately be made.

The 250-pound Booth furnace gave about the results to be expected from its similarity to the 125-pound rocking furnace. In a month's operation on a 9-hour schedule 18 tons, mostly red brass, were melted at 480 kilowatt hours per ton average. This amounted to about 1700 pounds in nine hours. Some days the power consumption was as low as 400 kilowatt hours per ton. Metal losses were 0.8 per cent on red brass and 1.4 per cent on yellow brass. Electrode consumption was 4 pounds of graphite per ton. The power factor of the furnace itself is 71 and of furnace plus transformer 63. This is below the point usually allowed and generally entails a penalty on power bills. The 250-pound Booth furnace is understood to be priced at about $3000, without transformer, primary switch, etc., which would raise the cost to around $4000.

One advantage claimed for the Booth furnace is that it can be picked up bodily by a crane for direct pouring. This might be an advantage in small sizes, but until it is actually tried out its value is unknown. The avoidance of an opening in the circumference of the furnace would give more stability to the lining and tend to increase lining life. If this could be done without involving electrode breakage it would be useful. However, it involves some difficulties in large furnaces due to the necessity of mounting the electrode support on the only available point, the door.

Whether the deviations from the rocking furnace design, shown by the later adaptations of the scheme of moving an indirect-arc furnace, are improvements or not will be shown when the later forms have had real commercial tests on furnaces of reasonably large capacity. Whatever the final embodiment of the rocking-furnace idea may be, it appears that the furnace in its present form shows ability to melt both brass and bronze economically.

There are at least 65 furnaces of this general type in use, or being installed for brass and bronze melting, with a total load of around 17,500 kilovolt-amperes. All other types of electric brass furnaces in use or being installed are calculated to have a total load of around 15,000 kilovolt-amperes. More than half of the total production of electric brass is made in furnaces of the rocking type, although the other types which average much smaller output per furnace, outnumber them.

The rocking-type furnace is then, one of the solutions of the brass-melting problem. Other types of furnaces which also offer solutions of the problem will next be discussed, after which the adaptability of the various types to different plant conditions will be considered briefly and with regard to practical conditions.

Recommends Standard Sizes for Shafting

THE desirability for reducing the number of sizes of shafting and in consequence the number of parts of power-transmission equipment that must be carried in stock long has been recognized. At the suggestion of the chairman of the committee on war industries readjustment of the American Society of Mechanical Engineers, a committee was formed to investigate the subject of the standardization of shafting sizes.

This committee was confronted with two distinct but closely related problems, viz., the standardization of the diameters of shafting used for the transmission of power; and the standardization of the diameters of shafting used by machinery manufacturers in making up their product.

A letter was sent to 36 of the largest manufacturers and dealers in transmission shafting asking for statistics on the consumption of each size of shafting handled by them. Some 20 of the largest concerns furnished complete statements of sales over periods of time chosen by themselves. These data were reduced by the committee to a uniform basis of percentages and plotted in the form of a diagram. From the diagram, it was evident which of the sizes were popular and generally sought.

In the letters to these firms, the committee expressed the opinion that the custom of using shafting $\frac{1}{16}$ inch under the unit size is so firmly established in this country that it would be unwise to attempt to adopt sizes in even inches and fractions as standard. It also was pointed out that certain sizes stand out prominently as popular sizes and that others are sold in relatively small quantities. It seemed quite feasible to select a series of standard sizes which would meet the popular demand and give a sufficient selection of sizes for general purposes and at the same time reduce the number of sizes now listed by the trade from some 50 or 60 down to 12 or 15.

The committee decided to lay the plan before some 225 large consumers of this material and invite their comment upon its desirability or feasibility and their advice as to the size interval between standard diameters which should be considered. In the case of machinery shafting the users were unanimous in their approval of the plan to standardize sizes, but recommendations as to size interval varied greatly. However, these recommendations, in so far as they were definite and specific enough, were tabulated and a diagram constructed showing the relative popularity of the various size increments for each inch of diameter. The net result of the investigation was to narrow down the standard to 15 sizes.

With these data accumulated and sifted down to usable form the committee felt that it was in a position to present its information and preliminary deductions to representatives of other interested organizations.

Having completed the first part of the work the committee submitted a progress report to the council in which it recommended the adoption and approval of the following lists of sizes as standard for the society:

Transmission Shafting in inches:

$\frac{15}{16}$, $1\frac{7}{16}$, $1\frac{15}{16}$, $2\frac{3}{16}$, $2\frac{7}{16}$, $2\frac{15}{16}$, $3\frac{7}{16}$, $3\frac{15}{16}$, $4\frac{7}{16}$, $4\frac{15}{16}$, $5\frac{7}{16}$, and $5\frac{15}{16}$.

Machinery Shafting:

Size intervals extending to 2½ inches by sixteenth inches; from 2½ inches to 4 inches, inclusive, by eighth inches; from 4 inches to 6 inches by quarter inches. This should simplify matters.

Standard Foundry Cost System-I

Predetermined Rates Explained—Cost Plan Divided Into Sections — Routine of Material, Labor, Expense and Production Are the Four Divisions Considered in This Article—Expense Account Numbers Tabulated

COMPILED BY
C. E. KNOEPPEL & CO., INC.
NEW YORK

IN PRESENTING this revision of the original bulletin on the cost accounting system no attempt is made to provide for all possible forms used in handling the various lines of routine of the general business operations. It is assumed that all companies have adequate purchasing and commercial accounting systems which would bring all purchases of materials, labor and expense items to certain prescribed ledger accounts, and that adequate invoicing methods are in vogue for sales. Only such documents as are actually necessary for the accounting of the costs will be mentioned in this bulletin in order to simplify the presentation.

Plan of the System

The plan of costs shown herewith is simple and is briefly outlined as follows:

The scheme really consists of three main stages:

First:
The proper distributing of purchases of material, labor and miscellaneous expense items to certain proper control accounts subject to further accounting by requisition, time cards, etc., to the proper cost accounts.

Second:
(a) The proper accounting of the use of materials, labor, etc., to productive and expense orders, and the transfer of same by summarized monthly journal entries, to the cost control accounts.
(b) Also the transfer from the cost accounts of metal and overhead accounts of the proper cost amounts at predetermined rates to the work in process account by journal entry.

Third:
The compilation of costs of product, which, summarized for the month, credit the work in process and charge sales cost by journal entries.

Before proceeding further it should be perfectly clearly defined in each mind the meaning of "predetermined rates."

In foundry costing particularly, the feature of predetermined rates is by far the greatest feature. Metal cost must be by pound of metal poured; molding and core burden by percentage on direct labor by each department; finishing cost by percentage on molding and core direct labor combined; annealing cost by pound on good castings, etc.

But even though we find the actual cost of each of the preceding monthly, it is absolutely improper, unfair and really impossible to use the actual figures of any one month or small group of months in the figuring of costs.

Take, for instance, the cost of melting. Last month we operated smoothly with no repairs of any great amount. This month quite a bit of brick repairs were necessary. Then suppose that next month something went wrong with the blower and we had a very heavy cost of repairs in damages done the cupola. In open-hearth furnaces this feature is very pronounced, as 300 heats may slide along smoothly and then start troubles resulting finally in a complete tear down to the checkers. Or perhaps even the checkers are plugged up. The same applies in perhaps less extent in all the burden and pound cost accounts.

It is apparent, therefore, that no one month's cost can fairly be taken. Nor even a small group of months. In fact, to be nearest safe, the average of a complete year and even more should be taken as the rate to be used in both estimates and actual costs, for each of the divisions mentioned in the second paragraph.

Bear in mind, however, that the actual cost of each rate is found each month, and in such detail that steps can be taken to study and improve the operating methods in order to make the average or predetermined rate good. In fact, the constant goal should be to beat it and make money by so doing.

In melting cost, molding burden-direct labor and all such cost accounts distributed by percentage and pound rates, the basis should be arrived at by using figures of expense. The basis on which the expense is figured should be at least a year's operation. Of course in starting new, this will be difficult; but this should be the aim.

Machine Hour Rates

In arriving at the predetermined rate per hour of the molding burden-machine hour, and the coremaking burden-machine hour, a little different procedure holds. Similarly to the preceding accounts, find as closely as possible the maintenance charges covering at least a year of all the machines the time of which is to be charged for; that is, all in the molding department in one group, and all in the core in another group. Then arrive at the total power charge for each group. Finally, assemble the proper depreciation for each group. All three of these items will of course be figured by each machine which enters into each group.

Next, compute the total machine hours possible, which is the number of normal working hours of your plant times the number of machines in each group. Then take 85 per cent of the total possible hours in each group as the basis of your rate. Finally divide the total cost for the period by the 85 per cent of total possible hours, thereby arriving at the standard rate to use.

In regular monthly working, it will be best to use the actually employed machine hours as the basis of monthly costs, as shown by the cost statements.

Cost Plan in Greater Detail

In more detail, the cost scheme deals with the subject as follows: The headings shown are those which appear on the cost sheet whereon the cost of a casting or classes is figured.

Direct Labor is charged to production orders which represent either individual patterns or classes of work. This labor consists only of that which is directly chargeable to the product manufactured. All other labor entering into pound or percentage rates is classed as indirect labor.

Metal Cost is assembled monthly in a melting cost account. This account is credited with the actual

System Is Basic

Several years ago, the American Foundrymen's association arranged with C. E. Knoeppel & Co., Inc., industrial engineers, to compile a cost accounting system applicable to all classes of foundries. This was prepared after careful study, and was sold to members of the association. Its value to those who adopted the plan induced the association to publish the details in full in the proceedings for 1919. *Built on broad general lines, the system may be adapted with a little study to the needs of practically any foundry regardless of its size or the class of work handled. It furnishes a common method of analysis, which if generally adopted, will give assurance that castings may be bought and sold upon a sound basis of actual cost plus a reasonable profit.*

metal poured at the predetermined rate, the balance showing whether operating over or under the proper rate.

Molding Burden—Direct labor is assembled monthly in the molding burden account, which account is credited at close of month with the amount of burden represented by the predetermined percentage of the actual direct molding labor for the month. The balance indicates whether operating over or under the required rate.

Molding Burden-Machine Hour is assembled monthly in the molding burden-machine hour account, and is credited at close of month with the amount represented by the actual number of machine hours consumed for its month on productive work at the predetermined rate per hour. This predetermined rate is designed to be figurd on the basis of a long average cost of items shown in the detailed directions later, divided by 85 per cent of the total possible machine hour of the equipment.

The balance remaining indicates whether operating above or below the required rate.

Core Burden-Direct Labor is assembled monthly and is treated same as molding burden except that core direct labor is the basis for percentage.

Core Burden-Machine Hour is operated for machine equipment for core department, exactly the same as for molding department.

Molding Sand Expense

Flask Expense—These two costs will in most cases be a part of the molding burden and are so shown here. But in steel plants particularly, they may be treated as separate costs, and are so arranged for in detailed expense classification. If so, they will be entirely eliminated from the molding burden, and a separate cost statement made for each. In this case the basis of predetermined rate for molding sand will be metal poured, and flask expense will be on basis of good castings.

Finishing Cost is assembled monthly and is treated same as molding and core except that combined molding and core direct labor is the basis for percentage.

An exception to this is in plants large enough to treat direct operations in this department as direct labor, in which case its own direct labor charged to production orders will become the basis for distribution of its burden, same as in molding and core departments.

Annealing Cost is assembled monthly in an account of same name, which account is credited with amount represented by number of pounds good castings at the predetermined rate per pound. The balance indicates whether operating over or under the required rate.

It might be stated here that the real correct basis for this cost should be the weights of castings *annealed* rather than the basis of total good castings produced. Those who will tally the castings annealed will get far more accurate costs by so doing, as this eliminates castings not annealed and brings in castings re-annealed as is often the case.

Actual Cost Sheet (also as estimate sheet). In order to assist in understanding the details following, it is suggested that at this point, immediately after reading the preceding pages, a study be made of the actual cost sheet data shown under Section V, "Cost Compilation." This will aid very much in understanding the details leading up to the costs and cost statements as shown.

The presentation of the methods following is divided into sections, each section representing a particular phase.

Section I—Material Routine; Section II—Labor Routine; Section III—Expense Routine; Section IV—Production Routine; Section V—Cost Compilation; Section VI—Journal Entries; Section VII—Plant Investment Classification; Section VIII—Depreciation; Section IX—General Ledger Accounts.

Section I
Material Routine

MATERIAL accounting presents particular difficulties due, probably, to the fact that it deals with tangible things and that practically all transaction are directly traceable as used for a particular purpose or as benefiting a particular department.

The material forms principally required for costkeeping purposes are:

1. Stock ledger (card or sheet).
2. Material requisition.
3. Material credit memorandum.

1. *Stock Ledger*—The stock ledger should be a complete record of each item of material showing quantity required, ordered, received and issued, and the unit and total value of such material.

Material accounts should be maintained in the general ledger representing at closing periods the value of materials on hand supported by the details of the stock ledger sheets or cards, which form a detailed analysis of each control account.

2. *Material Requisitions*—Material withdrawn from stock must be accounted for in the following manner, all requisitions, etc., showing clearly the use of, and order number chargeable with the materials used:

Melting Materials

The furnace or cupola reports, made out daily by the weigher or storeskeeper, give the quantity and kind of melting and fuel materials used, and the account numbers to be charged. From these reports the stores ledger is posted and the unit prices thereon are noted on the furnace reports and the amounts derived.

The furnace reports may then be sent to the cost department to serve as the basis for the charges, each month, to the expense accounts involved, or instead, classified material requisitions may be made up monthly and sent to the cost department.

Miscellaneous Materials

All material not included on the furnace report should be the subject of a material requisition made out at the time of withdrawal of material from stock. The course of the material requisition is as outlined above. The disposition of the requisition and the charges it carries will be treated of presently.

Recovered Material

Recoveries of over-iron, shot, spills, etc., should be shown on the daily cupola or furnace report.

3. *Material Credit Memoranda*—Material credit memoranda simply reverse the charge made on material requisitions and represent unused material being returned to stock for which corresponding credit must be given.

Note:—As far as possible all material should be kept in a neat orderly manner in well regulated stock rooms. Otherwise, it is exceedingly difficult to enforce requisition regulations.

Also all issuances of material should be accounted for with accuracy. Pig iron, scrap, and all materials should be carefully weighed; it is little use to run a cost method on guessed quantities.

Entering, Requisitions, Etc.

As requisitions for materials used are received by cost department, they will be entered on stock ledger, and priced and extended at the unit values shown on stock ledger.

Before filing under order numbers, the requisitions representing material drawn from each separate material control account should be added each day, and the total withdrawals for each control account entered on an accumulation sheet to run for the current month. The totals for the month of this accumulation sheet become the credits to the material control accounts in the monthly journal entry of distribution of materials. The debits of this entry are to the various expense accounts as described later.

Under "Expense Routine" is described in greater detail the use of the expense ledger charge slip, which in a large measure is like a material requisition, except that it charges material or service charges direct from the purchase entry to the expense accounts. This covers a large class of charges of intangible and evasive nature which are not properly or safely run through regular stock material accounts subject to requisition.

Section II
Labor Routine

LABOR accounting has two main elements—payroll compilation and labor distribution. Payroll compilation is comparatively simple, if the time has been correctly reported and recorded. Payroll compilation is merely the weekly summarizing of the wages earned by each employe daily. Labor distribution is the correct apportionment of wages against production orders or classes (direct labor). The chief difficulty is in the incorrect reporting of applied time by the men, faulty counting or reporting by the inspectors, incorrect scale reports and clerical errors by the timekeepers. As many safeguards as practicable should be adopted to insure the correct reporting of time, accurate counting and inspection reports and accurate clerical operation in the transcription of data.

The labor forms principally required for cost keeping purposes are:

1. Daily time ticket.
2. Payroll sheet.

1. *Daily Time Tickets*—The time tickets should be used to report the time spent on the various kinds of work performed. Only one job, either direct or indirect, should be on one time ticket. This is so that the time ticket may be filed under its order number, whereby the actual original entry becomes our cost entry.

The time tickets should provide the following information: Order number, pattern number, name of operation or work performed, machine number on which work performed, quantity completed, piece or hourly rate, elapsed time, wages earned, man number, and date.

In keeping time it should and must be verified daily that the total time represented by the time tickets agrees absolutely with that shown by the in-and-out clock cards rung by each man, which usually are the regular weekly cards.

The daily time tickets are filed by order numbers after entry on payroll as described immediately following:

2. *Pay Roll Sheet*—The pay roll sheet, a weekly sheet for each man, should perform two functions:

First:—Collate the pay of each man for week.

Second:—So enter the time cards, that a controlling distribution is made as between direct and indirect labor for the purpose of

(a) In the case of direct labor, give us the amount for each department as the basis of our journal entry, and

(b) In the case of indirect labor to give us a total which *must be equalled* by the total of the indirect labor in the various monthly expense and burden statements as explained later, and which will complete the journal entry of the distribution of labor.

The payroll sheet, therefore, should be so arranged as to have columns approximately as follows:

Day of month
Slip number
Order Number
Direct labor (main heading)
Hours
Amount
Indirect labor (main heading)
Hours
Amount
Total (main heading)
Hours
Amount

Additions of bonus, etc., or deductions of any nature will be made at close of week at bottom of sheet.

It is important to fully understand at this point that direct labor is only that which may be *directly* charged to the product being manufactured—such as molding and coremaking labor. In some large foundries, especially steel, the finishing operations of chipping, grinding and the like better may be handled as direct labor, but never where only one part of it can be charged directly to the product. Melting and annealing labor and the like are only chargeable to the product through a pound or percentage method; therefore, this class of labor can only be classed as indirect labor.

Labor Distribution

As stated before, the distribution as between direct and indirect becomes our most valuable control of further entries. The making up of the expense and cost accounts described in Section III depends on the totals as shown herewith for proof of accuracy.

There being a pay roll sheet for each man for week we have three points to handle to arrive at our proper results:

First:—To arrive at total plant pay roll, add by adding machine (or draw off on recap sheet) for the week:
(a) Total direct labor.
(b) Total indirect labor.
(c) Total pay for week.
This should be done by producing departments (melting, molding, core, etc.). This gives us the direct labor for the departments where same applies for the week covered by the pay roll.

Second:—Where a week straddles the end of a month, the pay roll sheet of each man has to be sub-totaled or split, in order to arrive at the actual earned pay roll for the days belonging in each separate month.

Third:—The totals of direct, indirect and total pay for each week and portion of week, for each given month must be recapped, which then gives us the monthly totals of each, separated into each producing department.

We now have our control figures of direct, indirect and total earnings for the month. The total direct for each department is our basis for transfer from pay roll account to work in process, and also the basis for crediting the operating burden accounts with the proper amount of burden for each department at the predetermined rates used, charging work in process. (See journal entries.)

Section III
Expense Routine

EXPENSE accounting deals with those disbursements which contribute to and are necessary in connection with the production of salable merchandise but which are not apparent or directly traceable in finished product; includes labor performed not directly traceable on the finished articles; includes expense materials consumed in the processes of production; includes all expenditures for maintenance of property, buildings and equipment; also small tools and supplies, insurance, taxes, depreciation, power, heat and light.

On account of the fact that the indirect costs are applicable to the cost of the product in various ways, a brief explanation of same is here made:

Melting Cost is distributed on the basis of cost per pound of metal poured. It is evident that the quantity of metal used in pouring a mold, including the casting itself and all sprue is the correct basis of the charge—at the pound rate—to that casting.

Molding Burden-Direct Labor is distributed by percentage on the direct molding labor, this being the most generally accepted manner of distributing this expense.

Molding Burden-Machine Hour is distributed on the basis of predetermined cost per hour, it being the natural method to charge for the use of machine equipment on the basis of the time it is used.

Core Burden-Direct Labor is on same basis as molding except, of course, being on direct coremaking labor.

Core Burden-Machine Hour—Same idea as in molding.

Molding Sand Expense (if used separately from being a part of molding burden) is distributed on the basis of metal poured. This is on account of the fact that the contact of metal is the regulating factor of destruction of sand, therefore total poured is the basis.

Flask Expense (if used) is on the basis of cost per pound of good castings produced.

Finishing Cost is distributed on basis of molding and core direct labor combined for the reason that molding direct labor represents the "outside" and the core direct labor the "inside" work necessary to properly clean the casting. This therefore, allocates greater finishing expense to cored castings as is proper.

Annealing Cost is distributed on basis of good castings, as there is the existing record of such basis. However, if one will, the even more correct basis should be that of castings actually annealed, although the basis of good castings is near enough correct in the majority of cases.

The preceding appear in the compilation of any casting or class plant cost. The following are expenses which, after being collected are apportioned or split down to the operating expense accounts.

Apportioned Expenses

Power, Light and Heat Expense is apportioned to the various operating expense and burden accounts on the best basis possible as representing the actual benefit received by each department. Metered consumption is of course best; estimates on basis of horsepower of motors, wattage of lamps for light charges, floor space for heating, etc., are next best, and the usual way.

Pattern Expenses are apportioned to the molding and core burden accounts on the basis of actual benefits received as explained in the detail directions.

General Expense is apportioned to the operation expense and burden accounts on the basis of the total labor cost, direct and indirect, of each operating department. For instance, the total direct labor plus the total indirect labor charged to expense orders in the molding department would be its basis; i. e., such a per cent of the general expense as its cost is of the total of all the departments.

Miscellaneous Items are apportioned to the operating expense and burden accounts according to the nature of the item—See under Group 8 following.

All possible expense should be charged directly to one of the operating expense or burden accounts. Where impossible the general expense, power, light and heat expense, etc., are to be used.

The items entering into each of the operating expense and burden accounts, and into the general accounts are clearly shown in the following pages. All charges come from time tickets, requisitions, etc., all of which must bear the expense code order number to which they belong.

Certain charges which are best made directly from the entry of a purchase are handled by the *expense ledger charge slip*, which shows date, account charged, amount of charge, date of invoice and description of what is charged. An invoice for such material is charged in the purchase register to *expense ledger account*, showing therewith the proper expense order number. An expense ledger charge slip is made out at the same time, which slip is the size of the material requisition. This slip is sent to the cost department, who file it with proper order number same as is done with a requisition. When costs are figured for month, the total of the expense ledger charge slips appearing in the various cost statements *must equal* the total of the expense ledger column in the purchase register for the same month. This is explained further under *Cost Compilation*.

If any foundry installing their methods are only a unit of a larger business, some method will necessarily be required to get charges for service to the foundry accounts in a manner to be checked up in some such manner as if the foundry department were a separate business.

Expense and Burden Accounts

In order to have an analysis of what makes up each expense and burden account for purpose of constant check on the expenditures of money, there follows a set of analytical expense orders, grouped in the necessary divisions or cost figuring.

The items shown may be changed to suit any plant; may be increased or de-

creased in number; but under no circumstances should any foundry attempt to do business without a fairly complete analysis along the lines shown.

These expenses are grouped as has been previously shown, but for reference are as follows:

Group 1—Melting Cost; Group 2—Molding Burden—Direct Labor; Group 3—Molding Burden—Machine Hour; Group 4—Core Burden—Direct Labor; Group 5—Core Burden—Machine Hour; Group 6—Finishing Cost; Group 7—Annealing Cost; Group 8—Apportioned Expenses: (a) Power, light and heat, (b) Pattern expenses, (c) General expense, (d) Miscellaneous items; Group 9—Administrative Expense; Group 10—Selling Expense.

LABOR MELTING EXPENSES GROUP 1

101—FOREMEN AND ASSISTANTS.
All amounts paid for services of general or supervising foreman.

102—TIMEKEEPERS AND OTHER CLERKS.
Salaries or wages of timekeepers or other clerks located in this department; includes, also, prorata amount of salaries or wages paid to timekeepers or other clerks serving this and another department.

103—UNLOADING MELTING MATERIALS.
Wages paid for unloading cars or boats containing melting materials if a short term or normal supply. If exceptional quantities are obtained for long term storage, the labor expense should be added to the invoice cost as are freight charges and disbursements charged accordingly.

104—CUPOLA OR FURNACE LOADERS.
Wages paid men for loading cupolas and oil furnaces and open-hearth steel furnaces, also melters at small pots for making crucible steel.

105—ELEVATOR AND CRANEMEN.
Wages paid for operating elevators and cranes in connection with handling melting materials.

106—BREAKING SCRAP.
Wages paid for breaking up scrap or otherwise preparing scrap for use in cupola or furnace.

107—HANDLING SLAG.
Wages paid for handling and removal of slag, collecting over-iron, shot, spills, etc.

108—TESTING MATERIALS AND PRODUCT.
All amounts paid laboratory employes engaged in analysis and test of melting materials and foundry product.

109—MELTING MATERIALS STORES LABOR.
Wages of men engaged in moving melting materials from storage areas to charging platform, excepting services of elevator and crane men

110—SICKNESS AND ACCIDENT RELIEF.
Wages paid to employes absent on account of sickness or accident. Allowance must be approved by Superintendent.

111—GENERAL LABOR.
Wages paid to miscellaneous general labor not provided for in this classification.

112—.....
113—.....

MAINTENANCE OF PROPERTY

121—BUILDINGS.
Labor and material used in repairing or partially renewing buildings or structures.

122—CUPOLAS OR FURNACES.
Labor and material used in repairing or partially renewing cupolas and furnaces; also their equipment for draft and circulation of air, as well as foundations.

123—CONVERTERS.
Labor and material used in repairing or partially renewing converters.

124—ELEVATORS, CRANES AND CONVEYORS.
Labor and material used in repairing or partially renewing elevators, cranes, conveyors, transfer tables, etc.

125—ELECTRICAL APPARATUS.
Labor and material used in repairing or partially renewing all electrical apparatus.

126—PIPE AND POWER LINES.
Labor and material used in repairing or partially renewing all piping, plumbing and electrical wiring inside of buildings, including drainage and sewer pipes, water, gas, air and oil pipes and their fittings; cables and wires for power and lighting circuits, including wiring devices.

127—PLATFORM AND STAIRWAYS.
Labor and material used in repairing or partially renewing charging platform and stairway.

128—.....
129—.....
130—.....

SUPPLIES

141—ALUMINUM.
142—BRICK.
143—CLAY.
144—COKE.
145—ELECTRODES.
146—FUEL OIL.
147—LIME.
148—LIMESTONE.
Self-explanatory.

149—LINING MATERIALS.
All miscellaneous lining materials used in the upkeep of ladles, stoppers, spouts, etc.

150—SAND.
Self-explanatory.

151—MISCELLANEOUS SUPPLIES.
Miscellaneous materials not otherwise provided for in this classification.

152—LABORATORY EXPENSE.
Expenditures in connection with the laboratory other than salaries or wages which are chargeable to Account No. 108.

153—.....
154—.....
155—.....

MOLDING BURDEN—DIRECT LABOR

201—FOREMEN AND ASSISTANTS.
All amounts paid for services of general or supervising foremen.

202—TIMEKEEPERS AND OTHER CLERKS.
Salaries or wages of timekeepers or other clerks located in this department; includes, also prorata amount of salaries paid to timekeepers or other clerks serving this and another department.

203—CUTTING SAND AND PREPARING FLOORS.
Wages paid for cutting sand and otherwise preparing the floors for molders.

204—CLOSING AND CLAMPING MOLDS.
Wages paid for all labor engaged in closing and clamping molds.

205—DRYING MOLDS.
Wages of men operating drying ovens in connection with dry-sand molding, both firing the ovens and drying the sand.

206—RUNNER CUPS.
Wages of men engaged in making runner cups or boxes.

207—BROKEN MOLDS.
Wages of men engaged in repairing and finishing broken molds.

208—CARRYING PATTERNS AND FLASKS.
Wages of men engaged in carrying patterns and flasks to and from storage.

209—POURING.
Wages of men engaged in work of pouring.

210—SHAKING OUT.
Wages of men engaged in shaking out castings

211—TAKING OUT REFUSE AND SCRAP.
Amounts paid for taking out and disposing of refuse and delivery of scrap.

212—CLEANING AND SWEEPING.
Amounts paid for services in sweeping, raking or otherwise cleaning the department.

213—CRANE OPERATOR.
Wages paid for services of cranemen in the department operations.

214—IDLE TIME.
Wages paid men for idle or unapplied time, and reason for the charge must always be given. Does not include allowances for sickness or accident.

215—SICKNESS AND ACCIDENT RELIEF.
Wages paid to employes absent on account of sickness or accident. Allowances must be approved by the Superintendent.

216—PATTERN STORAGE LABOR.
Wages of men engaged in receiving, storing and laying out patterns and core-boxes.

217—EXPENSE DUE TO ERRORS AND DEFECTS.
Expenses or losses due to errors of department employes whether mechanical or clerical, as for example; breakage, spoilage, misplacement or careless shop work of any kind.

218—GENERAL LABOR.
Wages paid to miscellaneous general labor not provided for in this classification.

219—.....
220—.....

MAINTENANCE AND SUPPLIES.

221—BUILDINGS.
Labor and material used in repairing or partially renewing buildings or structures.

222—MOLDING MACHINES. (Omit if Machine Rate used.)
Labor and materials used in repairing or partially renewing all molding machines other than jarring.

223—JARRING MACHINES. (Omit if Machine Rate used.)
Labor and material used in repairing or partially renewing all jarring machines.

224—AIR HOISTS.
Labor and material used in repairing or partially renewing all air hoists.

225—CRANES.
Labor and material used in repairing or partially renewing all cranes.

226—ELECTRICAL APPARTUS.
Labor and material used in repairing or partionally renewing all electrical apparatus.

227—SHOP FIXTURES.
Labor and material used in repairing or partially renewing all shop fixtures such as benches, racks, bins, lockers, railings, etc.

228—PIPE AND POWER LINES.
Labor and material used in repairing or partially renewing all piping, plumbing, and electric wiring inside of buildings, including drainage and sewer pipes, water, gas, air and oil pipes and their fittings; cables and wires for power and lighting circuits, including wiring devices.

229—SMALL TOOLS.
Labor and material used in repairing or partially renewing all small tools within the department which have a comparatively long term of usefulness; such as portable pneumatic rammers, chain hoists, screw or hydraulic jacks, hand trucks, chain and rope tackles, etc.

230—GAGGERS, CHILLS, CHAPLETS AND BOLTS.
231—NAILS.
232—LAMP BULBS.
Names of supplies—self-explanatory.

233—PATTERNS.
Labor and material used in the alteration and repair of patterns shall be accumulated under Account 702 and shall be transferred monthly to this account. Account 702 is a memorandum account only to be used as a basis in the apportionment of the Pattern Department expenses as described under account 702.

234—MOLDING SAND EXPENSE.
Expenses in connection with molding sand cost are such an important element in the operating of the Molding Department that provision is made herein for the directly traceable factors of molding sand cost which may be summarized as a separate schedule, if desirable, and so reported.

The following sub-accounts shall be used:

234—1 MOLDING SAND.
Cost of molding sand used during the month (i. e., invoice price plus transportation charges).

234—2 UNLOADING MOLDING SAND.
Wages paid for unloading cars or boats containing molding sand if a short term or normal supply. If exceptional quantities are obtained for long term shortage, the labor expense should be added to the invoice cost as are freight charges and disbursement charged accordingly.

234—3 MIXING MOLDING SAND.
Wages of men engaged in mixing molding sand including preparation and wheeling.

234—4 MAINTENANCE OF MIXERS.
Labor and material used in repairing or partially renewing sand mixers.

234—5 MISCELLANEOUS SUPPLIES.
All incidental and miscellaneous supplies not otherwise provided for in this classification.

234—6 MISCELLANEOUS EXPENSES.
All other incidental and miscellaneous disbursements not provided for in this classification.
Molding sand cost, if reported as a separate factor, should be liquidated at a cost per pound of metal poured, or, else, included in the departmental burden and those combined in the departmental percentage on direct labor.

235—FLASKS.
Expenses in connection with flask cost are also such an important element in the operating of the molding department that provision is made herein for the directly traceable factors of flask cost which may be summarized as a separate schedule, if desirable, and so reported. The following sub-accounts shall be used:

235—1 WOOD FLASKS AND BOTTOM BOARDS.
Labor and material used in making (unless for special orders) repairing or replacing wood flasks or bottom boards shall be accumulated under Account 704 and shall be transferred to this account. Account 704 is a memorandum account only to be used as a basis in the apportionment of the pattern department expenses as described under Account 704.

235—2 SNAP FLASKS AND JACKETS.
Labor and material used in repairing

or partially renewing snap flasks and making new or replacing old wood jackets shall be accumulated under Account 705 and shall be transferred to this account. Account 705 is a memorandum account only to be used as a basis in the apportionment of the pattern department expenses as described under Account 705.

235—3 METAL FLASKS.
Labor and material used in repairing or partially renewing all metal flasks.

235—4 FLASK PLATES.
Labor and material used in repairing or partially renewing all flask plates.

236—NONDURABLE TOOLS.
Cost of repairing and renewing all tools and equipment of a nondurable nature and classed as a miscellaneous shop supply. This account is intended to cover mainly those classes of portable tools which are short lived and comparatively inexpensive. All current expenditures for nondurable tools should be distributed to this account whether such expenditures represent initial cost of additions or replacements of the nondurable tool equipment.

237—METAL ARBORS AND CORES.
Labor and material used in repairing or partially renewing all metal arbors and cores.

238—MISCELLANEOUS SUPPLIES AND EXPENSES.
Incidental and miscellaneous disbursements not otherwise provided for in this classification.

239—.....
240—.....

MOLDING BURDEN—MACHINE HOUR GROUP 3.

251—MAINTENANCE OF MOLDING MACHINES.
Labor and material used in repairing or partially renewing all molding machines other than jarring machines.

252—MAINTENANCE OF JARRING MACHINES.
Labor and material used in repairing jarring machines.

COREMAKING BURDEN—DIRECT LABOR

301—FOREMEN AND ASSISTANTS.
All amounts paid for services of general or supervising foremen.

302—TIMEKEEPERS AND OTHER CLERKS.
Salaries or wages of timekeepers or other clerks located in this department; includes also prorata amount of salaries or wages paid to timekeepers or other clerks serving this and another department.

303—INSPECTING CORES.
Wage of Inspectors engage in the inspection of cores.

304—UNLOADING CORE SAND.
Wages paid for unloading cars or boats containing core sand if a short term or normal supply. If exceptional quantities are obtained for long term storage the labor expense should be added to the invoice cost and freight charges and disbursement charged accordingly.

305—WHEELING AND MIXING CORE SAND.
Wages of men engaged in mixing core sand including preparation and wheeling.

306—UNLOADING AND TENDING OVENS.
Wages of men operating drying ovens in connection with baking cores, including firing the oven.

307—HANDLING CORES.
Wages of men engaged in handling cores to and from storage.

308—REPAIRING CORES.
Wages of men engaged in repairing defective cores.

309—CRANE OPERATOR.
Wages paid for services of cranemen in the department operations.

310—STORING CORES.
Wages of men engaged in receiving, storing and laying out cores.

311—SICKNESS AND ACCIDENT RELIEF.
Wages paid to employes absent on account of sickness or accident. Allowance must be approved by the Superintendent.

312—EXPENSE DUE TO ERRORS AND DEFECTS.
Expenses or losses due to errors of department employes whether mechanical or clerical, as for example: breakage, spoilage, misplacement or careless shop work of any kind.

313—GENERAL LABOR.
Wages paid to miscellaneous general labor not provided for in this classification.

314—.....
315—.....

MAINTENANCE AND SUPPLIES.

321—BUILDINGS.
Labor and material used in repairing or partially renewing buildings and structures.

322—COREMAKING MACHINES. (Omit if Machine Hour Rate Used.)
Labor and material used in repairing or partially renewing all coremaking machines.

323—SAND MIXING MACHINES.
Labor and material used in repairing or partially renewing core sand mixing machines.

324—ELECTRICAL APPARATUS.
Labor and material used in repairing or partially renewing all electrical apparatus.

325—CORE OVENS.
Labor and material used in repairing or partially renewing all core ovens.

326—SHOP FIXTURES.
Labor and material used in repairing or partially renewing all shop fixtures, such as benches, racks, bins, lockers, railings, etc.

327—PIPE AND POWER LINES.
Labor and material used in repairing, or partially renewing all piping, plumbing, and electric wiring inside of buildings, including drainage and sewer pipes, water, gas and oil pipes.

328—CRANES.
Labor and material used in repairing or partially renewing all cranes.

329—PLATES.
Labor and material used in repairing or partially renewing all core plates.

330—SMALL TOOLS.
Labor and material used in repairing or partially renewing all small tools within the department which have a comparatively long term of life.

331—CORE BOXES.
Labor and material used in the alteration and repair of core boxes shall be accumulated under account 703 and shall be transferred monthly to this account. Account 703 is a memorandum account only to be used as a basis in the apportionment of the Pattern Department expenses as described under account 703.

332—FUEL CONSUMED.
Includes the cost of all fuel used in the core ovens.

333—CORE SAND.
334—CLAY.
335—CORE COMPOUND AND OIL.
336—FLOUR.
337—SILICA WASH.
338—RODS, WIRES, NAILS.
Names of supplies—self-explanatory.

339—MISCELLANEOUS SUPPLIES AND EXPENSES.
All incidental and miscellaneous disbursements not provded for in this classification.

340—.....
341—.....

COREMAKING BURDEN—MACHINE HOUR GROUP 5.

351—MAINTENANCE OF COREMAKING MACHINES.
Labor and materials used in repairing coremaking machines.

LABOR. FINISHING COST GROUP 6.

401—FOREMEN AND ASSISTANTS.
All amounts paid for services of general or supervising foremen.

402—TIMEKEEPERS OR OTHER CLERKS.
Salaries or wages of timekeepers or other clerks located in this department; includes also, prorata amount of salaries or wages paid to timekeepers or other clerks serving this and another department.

403—INSPECTORS.
Wages of Inspectors engaged in departmental inspection work.

404—CRANE OPERATORS.
Wages paid for services of cranemen in the departmental operations.

405—HANDLING GOOD PRODUCT.
Wages for handling good product in finishing department and piling good castings in storage areas.

406—TAKING OUT REFUSE AND SCRAP.
Wages paid for collecting and disposing of refuse and scrap.

407—CLEANING AND SWEEPING.
All amounts paid for service in raking, sweeping or otherwise cleaning the department.

408—UNLOADING MISCELLANEOUS MATERIALS.
Wages paid men for unloading miscellaneous materials of short term supply excepting as otherwise provided for in this classification.

409—EXPENSES DUE TO ERRORS AND DEFECTS.
Expenses or losses due to errors of department employes whether mechanical or clerical, as for example; breakage, spoilage, misplacement or careless shop work of any kind.

410—SICKNESS AND ACCIDENT RELIEF.
Wages paid to employes absent on account of sickness or accident. Allowances must be approved by the Superintendent.

411—GENERAL LABOR.
Wages paid to miscellaneous general labor not provided for in this classification.

412—SHIPPING EXPENSE LABOR.
Wages paid shipping department helpers and laborers wherever located.

413—.....
414—.....

MAINTENANCE AND SUPPLIES.

421—BUILDINGS.
Labor and material used in repairing or partially renewing buildings or structures.

422—TUMBLERS.
Labor and material used in repairing or partially renewing all tumbling barrels or rolling mills.

423—GRINDERS.
Labor and material used in repairing or partially renewing all grinders. Does not include grind stones or emery wheels.

424—MACHINERY.
Labor and material used in repairing or partially renewing all transmission machinery within the department.

425—AIR TOOLS.
Labor and material used in repairing or partially renewing all air tools and connections used in the department.

426—CRANES.
Labor and material used in repairing or partially renewing all cranes, chain hoists and mechanical conveyors used in the department.

427—ELECTRICAL APPARATUS.
Labor and material used in repairing or partially renewing all electrical apparatus.

428—SAND BLAST APPARATUS.
Labor and material used in repairing or partially renewing sand blast apparatus.

429—CUTTING AND WELDING EQUIPMENT.
Labor and material used in repairing or partially renewing all cutting and welding equipment.

430—SHOP FIXTURES.
Labor and material used in repairing or partially renewing all shop fixtures, such as benches, racks, bins, lockers, railings, etc.

431—PIPE AND POWER LINES.
Labor and material used in repairing or partially renewing all piping, plumbing and electric wiring inside of buildings, including drainage and sewer pipes, water, gas, air and oil pipes and their fittings; cables and wires for power and lighting circuits, including wiring devices.

432—OTHER EQUIPMENT.
Labor and material used in repairing or partially renewing all other equipment not provided for in this classification.

433—SAND FOR SAND BLAST.
Cost of sand used in sand blasting during the month (i. e., invoice price plus transportation charges).

434—NONDURABLE TOOLS.
Cost of repairing and renewing all tools and equipment of a nondurable nature, excepting emery wheels, not classed as a miscellaneous shop supply. This account is intended to cover mainly those classes of portable tools which are short lived and comparatively inexpensive. All current expenditures for nondurable tools should be distributed to this account whether such expenditures represent initial cost of additions or replacement of the nondurable tool equipment.

435—ELECTRIC LAMPS.
Expense in connection with lamp globes, carbons and bulbs.

436—EMERY WHEELS.
Expense of emery wheels used in the finishing department. This account is used to exclude the expenses of emery wheels from Account 434, Nondurable Tools.

437—CARBIDE, HYDROGEN AND OXYGEN.
Cost of carbide, hydrogen and oxygen used during the month in cutting and welding processes.

438—WELDING MATERIAL.
Cost of all welding supplies such as metal sticks or wire, flux, etc.

439—SHIPPING EXPENSE MATERIALS.
Cost of all miscellaneous materials used in connection with shipping expense operations.

440—INSPECTION EXPENSE.
All incidental and miscellaneous expenditures (excepting labor) in connection with inspection of the company's product.

441—OTHER MATERIALS AND EXPENSES.
All incidental and miscellaneous, disbursements not otherwise provided for in this classification.

442—.....
443—.....

ANNEALING COST. GROUP 7

501—FOREMEN.
All amounts paid for services of foremen.

502—OVEN TENDERS.
Wages of men operating annealing ovens including firing.

503—PACKING LABOR.
Wages paid for packing castings in annealing boxes or pots, or loading annealing cars.

504—PACKING MATERIALS.
Cost of packing materials used in annealing pots or boxes.

505—EXPENSES DUE TO ERRORS AND DEFECTS.
Expenses or losses due to errors of department employes whether mechanical or clerical, as for example, breakage, spoilage, misplacement or careless shop work of any kind.

506—BOXES.
Cost of annealing boxes used during the month.

507—FUEL CONSUMED.
Cost of all fuel used in the annealing ovens.

508—MAINTENANCE OF OVENS.
Labor and material used in repairing or partially renewing all annealing ovens.

509—MAINTENANCE OF ELECTRICAL APPARATUS.
Labor and material used in repairing or partially renewing all electrical apparatus.

510—MAINTENACE OF BUILDINGS.
Labor and material used in repairing or partially renewing buildings or structures.

511—MAINTENANCE OF MISCELLANEOUS EQUIPMENT.
Labor and material used in repairing or partially renewing all other equipment not provided for in this classification.

512—SHEET IRON USED IN MUFFLE FURNACES.
Cost of all sheet iron used in muffle furnaces.

513—MISCELLANEOUS SUPPLIES.
Cost of all miscellaneous supplies (other than enumerated above) consumed in the current operations of the annealing departments.

514—.....
515—.....

APPORTIONED EXPENSES GROUP 8.

1—POWER, HEAT AND LIGHT. (See detail 8a.)
Includes total of Group (8a) Power, Heat and Light Expenses, which amount shall be distributed on the proportionate basis of—

(a) **Power:** On the estimated used horsepower of motors installed in each department, to the total horsepower used in all departments.

(b) **Heat:** On the ratio of the floor space of each department heated to the total floor space of all departments heated.

(c) **Light:** On the wattage of lamps installed in each department to the total wattage installed in all departments.

2—PATTERN EXPENSES. (See detail 8b.)
Includes total of Group 8b Pattern Expenses, which amount shall be distributed against The Molding and Coremaking departments on the established proportionate basis of the benefits derived by each.

3—GENERAL EXPENSES. (See detail 8c.)
Includes total of Group 8c General Expenses, which amount shall be distributed to the following accounts: (a) cost of melt; (b) molding burden; (c) coremaking burden; (d) finishing cost; and (e) annealing cost, on a percentage basis equivalent to total labor cost direct and indirect in the respective departments.

4—BONUS.
(a) **Attendance:** Based on percentage of earnings during six consecutive days' full time attendance. Bonus to be distributed against department in which it is earned.

(b) **Quantity:** Based on quantity production weekly or monthly. Bonus to be distributed against department in which it is earned.

5—DEPRECIATION.
Represents a monthly charge equivalent to the lessening value of investments as represented by building, machinery, electrical apparatus, furniture and other permanent equipment, the charge being based on a standard rate of percentage of the ledger values of the investment accounts which shall be chargeable against the expenses of the various departments according to the value of the departmental investment.

6—INSURANCE.
(a) **Fire Insurance.**
Includes the cost of fire insurance premiums. Charges to this expense shall be credited to such an account as "Unexpired Insurance" and be distributed monthly against the various departments on the basis of value involved.

(b) **Group Life Insurance.**
Includes the cost of group life insurance premiums distributed monthly against the various expense groups (i. e., Groups 1 to 8 inclusive) based on the number of employes in each department.

(c) **Liability Insurance.**
Includes cost of all premiums on employers' liability insurance and is to be distributed monthly on a proportionate percentage of the payroll of each department.

7—TAXES.
Includes all payments for taxes and assessments on real estate and personal property used for manufacturing purposes, excepting water taxes. The estimated cost of taxes is to be credited to an account such as "Taxes Accrued" and charged in monthly proportions against the various departments on the basis of the ratio of taxable values in each department to the total taxable values in all departments.

POWER, HEAT AND LIGHT EXPENSES. GROUP 8-a.

601—POWER PLANT AND SUB-STATION LABOR.
All amounts paid for services of engineer, firemen, electrician, or other supervision and labor in connection with the power plant or sub-station.

602—MAINTENANCE OF POWER PLANT EQUIPMENT.
Labor and material used in repairing or partially renewing all power plant equipment excepting stationary boiler.

603—MAINTENANCE OF SUB-STATION EQUIPMENT.
Labor and materials used in repairing or partially renewing all sub-station equipment such as transformers, switchboard, general power lines and all other miscellaneous electrical apparatus used in distributing or measuring electrical current.

604—OILS AND WASTE.
Cost of all lubricating oils, greases and waste.

605—ELECTRIC LAMPS.
Expenses in connection with lamp globes, carbons and bulbs.

606—FUEL CONSUMED.
Cost of coal or other fuel actually consumed based on periodical reports of consumption.

607—MAINTENANCE OF POWER PLANT BUILDINGS.
Labor and material used in repairing or partially renewing all power plant buildings and structures.

608—MAINTENANCE OF BOILER AND EQUIPMENT.
Labor and material used in repairing or partially renewing stationary steam boilers or other apparatus used in connection with the generation or distribution of steam, as injectors, draft system, pipes and fittings, water pumps, etc.

609—CURRENT PURCHASED.
Cost of all electric current purchased for either power or light.

610—MISCELLANEOUS EXPENSES.
Miscellaneous expenses not otherwise provided for in this classification.

611.....
612.....

Note No. 1—If compressed air is used in quantity and is supplied from a central station, it is recommended that a separate group expense be used like the "Power, Light and Heat" and handled in same way.

In many plants, however, a compressor is in each department where used, which of course would simply throw it in the expense account of the department.

In larger plants, however, a separate account should be used in similar manner to Power, Light and Heat.

Note No. 2—In large plants it is recommended to split Group 8-a, Power, Light and Heat, separating into an expense account for "Electric" and another for "Steam" expense. The same principles will govern and can easily be followed out.

PATTERN SHOP EXPENSES GROUP 8-b.

701—FOREMAN.
Wages for foreman for time spent in supervision. Does not include wages of working foreman which can be directly distributed against pattern orders, shop orders or other standing expense accounts.

702—ALTERATIONS AND REPAIRS TO PATTERNS.
Labor and material used in the alteration or repair of standard patterns owned by the company to suit the needs of the foundry. Does not include labor and material used in the alteration or repair of patterns which are customers' property; does not include labor and material used in making new patterns which are chargeable to customers or an investment account.
The total amount charged to this account shall be deducted from pattern shop expenses and transferred to Account 233, Patterns, together with a proportion of the residual pattern shop expenses after values in Accounts 702, 703, 704 and 705 have been deducted from charges to this expense group. The proportion shall be based on a percentage basis of the ratio of the value in Account 702 to the total of the values in Accounts 702, 703, 704, 705.

703—ALTERATIONS AND REPAIRS TO CORE BOXES.
Labor and material used in the alterations or repair of standard core boxes owned by the company to suit the needs of the foundry. Does not include labor and material used in the alteration or repair of core boxes which are customers' property; does not include labor and material used in making new core boxes which are chargeable to customers or an investment account.
The total amount charged to this account shall be deducted from pattern shop expenses and transferred to Account 331, Core Boxes, together with a proportion of the residual pattern shop expenses after values in Accounts 702, 703, 704 and 705 have been deducted from charges to this expense group. The proportion shall be based on a percentage basis of the ratio of the value in Account 703 to the total of the values in Accounts 702, 703, 704, 705.

704—MAKING NEW OR REPLACING OLD WOOD FLASKS.
Labor and material used in making new, repairing or replacing old wood flasks or bottom boards.
The total amount charged to this account shall be deducted from pattern shop expenses and transferred to Account 235-1, wood flasks and bottom boards, together with a proportion of the residual pattern shop expenses after values in Accounts 702, 703, 704 and 705 have been deducted from charges to this expense group. The proportion shall be based on a percentage basis of the ratio of the value in Account 704 to the total values in Accounts 702, 703, 704, 705.

705—MAINTENANCE OF SNAP FLASKS.
Labor and material used in repairing or partially renewing snap flasks and making new or replacing old wood jackets.
The total amount charged to this account shall be deducted from pattern shop expenses and transferred to Account 235-2, snap flasks and jackets, together with a proportion of the residual pattern shop expenses after values in Accounts 702, 703, 704 and 705 have been deducted from charges to this expense group. The proportion shall be based on a percentage basis of the ratio of the value in Account 705 to the total values in Accounts 702, 703, 704, 705.

706—MAINTENANCE OF BUILDINGS.
Labor and material used in repairing or partially renewing buildings or structures.

707—MAINTENANCE OF MACHINERY.
Labor and material used in repairing or partially renewing all machinery in pattern shop.

708—MAINTENANCE OF SHOP FIXTURES.
Labor and material used in repairing or partially renewing all shop fixtures, such as benches racks, bins, lockers, railings, etc.

709—MISCELLANEOUS LUMBER.
Cost of all lumber for miscellaneous purposes, not provided for in this classification. All charges possible should be made against Accounts 702 to 705 inclusive.

710—NONDURABLE TOOLS.
Cost of repairing and renewing all tools and equipment of a nondurable nature. This amount is intended to cover mainly those classes of portable tools which are shortlived and comparatively inexpensive. All current expenditures for nondurable tools should be distributed to this account whether such expenditures represent initial cost of additions or replacement of the nondurable tool equipment.

711—MISCELLANEOUS SUPPLIES AND EXPENSES.
Miscellaneous disbursements not otherwise provided for in this classification.

712.....
713.....

GENERAL EXPENSES. GROUP 8-c.

801—SALARIES—DEPARTMENT HEADS.
Salaries of managers, general superintendents and those having supervision over a regularly established **general** department. (Not a producing department.)

802—SALARIES—CLERICAL.
Salaries and wages of all office clerks not directly distributable to a departmental expense account.

803—YARD LABOR.
Wages paid men engaged in general yard labor not distributed to other accounts provided herein.

804—GENERAL LABOR.
Wages paid men engaged in unclassified work not distributed to other accounts in this classification.

805—GENERAL REPAIR MEN.
Wages only of employes in the maintenance department which are not distributable directly to specific accounts as provided for in this expense classification.

806—SICKNESS AND ACCIDENT RELIEF.
Wages paid to employes absent on account of sickness or accident, which are not chargeable to operating departments. Allowances must be approved by the Superintendent.

807—PRINTING AND STATIONERY.
Cost of all printed forms and stationery used during the month by plant departments.

808—OFFICE SUPPLIES.
Cost of all minor office supplies and conveniences used by plant offices.

809—TRAVELING EXPENSES.
All payments for transportation, hotel and other necessary expenses in connection with foundry requirements other than administrative and selling.

810—TELEPHONE AND TELEGRAPH.
Expense of all local and long distance public telephone service, the rental of interior service and a proportion of wages of the switchboard operator based on services performed. Includes expense of telegraphing. All the preceding applies to Plant Operations.

811—CAR DEMURRAGE.
All amounts paid as demurrage for detention of cars belonging to railroad companies.

812—GENERAL STORES EXPENSE.
Wages of storekeeper and assistants engaged in the receiving, storing and delivery of general stores. This account also includes office supplies and stationery used in connection with the above function.

813—WATCHMEN'S EXPENSE.
Wages paid watchmen and other miscellaneous expenditures in connection with watchmen's service.

814—BLACKSMITH SHOP EXPENSES.
All expenditures in connection with the blacksmith shop not distributable directly to some other account. Includes labor and material and all prorations applicable to the blacksmith shop.

815—REPAIR DEPARTMENT EXPENSES.
All expenditures in connection with the repair or maintenance department not distributable directly to some other account. Includes labor and material and all prorations applicable to the repair department.

816—TRUCKING OR TEAMING EXPENSES.
All expenditures in connection with garage and automobile service, stable and cartage service and all payments for all miscellaneous and unassignable hired cartage of material and supplies, both incoming and outgoing.

817—MAINTENANCE OF OFFICE BUILDING.
All labor and material used in repairing or partially renewing office building.

818—MAINTENANCE OF BUILDINGS AND EQUIPMENT. (GENERAL.)
All labor and material used in repairing or partially renewing buildings and equipment when such charges cannot be distributed against a particular department as provided for in this classification.

819—MAINTENANCE OF YARDS, FENCES AND GROUNDS.
All labor and material used in repairing or partially renewing all roadways, sidewalks, fences, regrading of yards, maintaining lawns and all tools and implements used exclusively in connection therewith.

820—MAINTENANCE OF TRACKS.
All labor and material used in repairing or partially renewing all railway tracks in yards and shops, including turntables and tracks on trestles.

821—REPAIRS ON RETURNED MATERIAL.
Wages paid for reclaiming processes on returned material to restore such material to salable condition if defect is not directly traceable to an operating department.

822—MISCELLANEOUS EXPENSES.
Miscellaneous disbursements not otherwise provided for in this classification.

ADMINISTRATIVE EXPENSES. GROUP 9.

1001—EXECUTIVES' SALARIES.
Compensation of corporate and general executive officers. Executive officers engaged in sales work should be charged directly to Account No. 1101—Salaries, under Group 10, Selling Expenses.

1002—OFFICE SALARIES.
Salaries of all clerks, including stenographers, reporting directly to the executive officers.

1003—OFFICE SUPPLIES AND EXPENSES.
Cost of all stationery, printed forms, office supplies and miscellaneous expenditures made in connection with executive offices.

1004—TRAVELING EXPENSES.
Payments for transportation, hotel and other necessary expenses, including entertaining incurred by executive officers.

1005—ASSOCIATION DUES.
Membership fees in trade or manufacturing associations.

1006—CHARITIES.
Cost of all voluntary subscriptions to hospitals or other local charity organizations.

1007—MISCELLANEOUS EXPENSES.
Miscellaneous disbursements not otherwise provided for in this classification.

SELLING EXPENSES. GROUP 10.

1101—SALARIES.
Salaries of sales manager, sales department representatives and clerks.

1102—COMMISSIONS.
All amounts accrued as commissions to salesmen based on sales billed (or orders taken) during the month.

1103—TRAVELING EXPENSES.
All payments for transportation, hotel and other necessary expenses including entertaining, incurred by sales department representatives.

1104—OFFICE SUPPLIES AND EXPENSES.
Cost of all stationery, printed forms, office supplies used, and miscellaneous expenditures made in connection with the sales department.

1105—ADVERTISING.
Cost of all catalogs, price lists, stock lists, and all other printed matter intended to be of sales assistance. Includes payment for advertisements descriptive of the company's business or product inserted in newspapers, magazines, trade publications, etc., also cuts, electros, etc., used in connection therewith. Includes cost of samples for use of salesmen.

1106—TELEPHONE AND TELEGRAPH.
Local and long distance public telephone service, the rental of interior service, and a proportion of the wages of the switchboard operator based on services performed. Includes expense of telegraphing.

1107—POSTAGE.
Self-explanatory.

1108—MISCELLANEOUS EXPENSES.
Miscellaneous disbursements not otherwise provided for in this classification.

Section IV
Production Routine

ALL castings made should be authorized by a casting production order which should be in sufficient copies to notify the various departments interested of the exact requirements involved and to prevent over-fulfillment of requirements. The order should show clearly the order number or class number chargeable, in order that the application of cost may be dependable. A work-in-process record by pattern numbers should be maintained showing the order number and number of castings ordered and completed, as well as dates of the transactions. Dependable reports should be made showing the number of castings made daily, good and defective, and the corresponding weights by order or class number and pattern numbers.

Book Review

Metallography; by Samuel L. Hoyt, metallurgical engineer, National Lamp Works, General Electric Co., and formerly associate professor of metallography, the University of Minnesota; cloth; 6 x 9 inches; published by McGraw-Hill Book Co., Inc., New York, and furnished by THE FOUNDRY for $3 net.

An exhaustive and comprehensive work on the science and application of metallography. The subject has been divided into three parts by the author: Part I, *Principles of Metallography,* a book of 251 pages, is now ready for distribution. Part II, *The Metals and Common Alloys,* is on the press. Part III, *Technical Practice,* is in preparation. The first book is the outgrowth of a lecture course given at the University of Minnesota to students specializing in metallography. It deals with the general principles of the science and with some of the more important methods which are used to carry out general investigations in the metallographic laboratory. Parts 2 and 3 will deal with the metallography of the more important metals and alloys, including steel, cast iron and special steels and the application of metallography to the metallurgical and engineering industries. In the first volume, general principles are discussed in seven chapters and under numerous subheads.

Takes Over Lynchburg Plants

The James River Foundry Co. and the C. W. Hicks Machine Works have been taken over by the Southern Electro Steel Co., Inc., Lynchburg, Va. In addition, the company is having plans prepared for a modern electric steel foundry. The former owners of the firms taken over, William Farmer and C. W. Hicks, have been retained by the purchasing company to act as superintendents in the respective plants.

Foundry Company Incorporated

The Gold Coin Stove & Foundry Co., 26 DeWitt street, Albany, N. Y., recently was incorporated to take over the present plant of the Gold Coin Stove & Foundry Co., 16-22 DeWitt street. Announcement concerning election of officers will be made later, but it already has determined to build a new foundry, equipped with modern appliances.

Exports Tire Molds

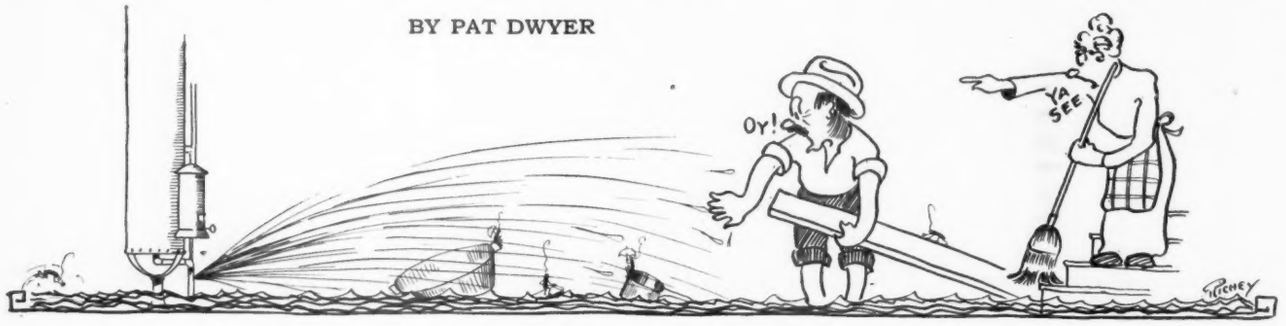
Export of the products of the tire mold division of the Wilson Foundry & Machine Co., Pontiac, Mich., recently was initiated by the shipment of 12 tire molds and 150 tire cores to the Dunlop Rubber Co., Aston, England. Special heavy crates were prepared for the initial consignment to England, which comprised 87 crates, the total weight being over 30 tons.

Will Manufacture Axles

The United States Axle Co. has been organized at Pottstown, Pa., to take over the plant of the Industrial Foundry & Machine Co., of that city. The new company will install additional machinery for the manufacture of axles for motor vehicles. The officers are: President, George C. Lee, Pottstown; vice president, D. L. Britton; secretary-treasurer, L. E. Orgill. In addition to the officers, the board of directors is comprised of H. C. Lang, New York, and Dwight R. Heigs, of Pottstown, Pa.

Bill Comments on Blast Furnace Coolers

BY PAT DWYER

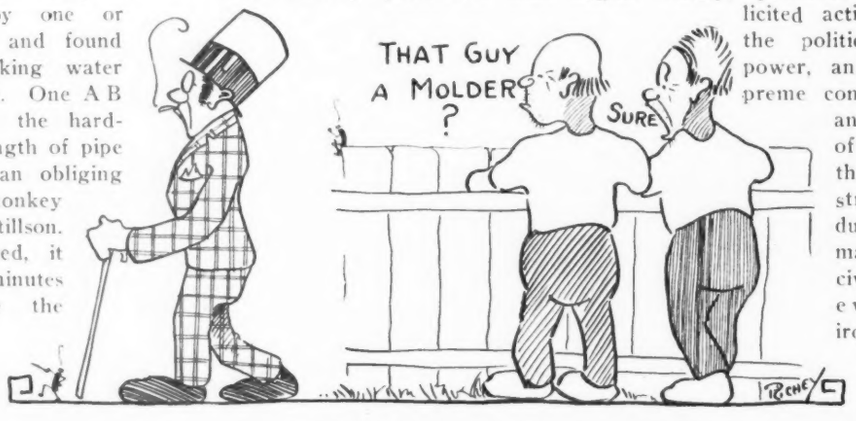


HAVING finished the arduous duties of the day as one of the cogs of the wheel of industry, I removed the grime from my person, put on my coat and after contributing a nickel to help swell the coffers of the corporation which controls the traction rights in the city, I found myself a half an hour later entering the front door of the house which I am buying in monthly installments—for another man. Before I had time to call the roll or even see what was spread on the frugal board, I was told by the Chief of the Bureau of Domestic Relations that one of the hot water connections on the boiler in the cellar was broken and she was afraid it would be necessary to take to the boats before morning. I consoled her by remarking that if there was anything left after we had eaten, we would provision the long boat and then it would make no difference to us whether the ship went down or not, as we did not own her. With the peculiar inconsistency of her sex, she could not see it that way and insisted that I go down at once and fix the leak. I remonstrated gently, but firmly withall, that if I were going to drown I preferred to do it comfortably on a full stomach and without a collar.

After the meal I went down into the fore-hold being accompanied and escorted thither by one or two trusty A Bs and found that she was making water through a split pipe. One A B was dispatched to the hardware store for a length of pipe and the other to an obliging neighbor for a monkey wrench and a stillson. When they returned, it was only a few minutes work to remove the broken piece, insert the new one and connect her up again. We turned on the water and were engaged in contemplating the masterpiece when Bill appeared at the hatchway and sang out: "Ship ahoy! Do you want a tow line?" I told him that I thought we could make port under our own steam and asked him to come down if he wanted to see a classy piece of deep sea engineering. He did so and after having given the job his unqualified approval he said: "This here pipe-fitting business is more important than some people think. I worked in a foundry at one time which turned out most of the castings for a neighboring steel works. The steel plant was a modest affair, in fact not much more than an infant in those days, comprising as it did a couple of open hearths, a forge, a guide mill and a cogging mill. 'Twas a strong, lusty infant though and in recent years has attained a stature which reflects credit on the men responsible for shaping its destinies. It also furnishes a theme for the local spellbinders when they wish to extoll the merits of a protective tariff as applied to the iron and steel industry in one of His Most Gracious Majesty's overseas dominions.

"Prompted solely by the most pure and patriotic motives, the owners of the plant in the early days made representations to those who sit in high places, to-wit, the government benches; and humbly petitioned that august body to enact certain measures which would encourage the manufacture of pig iron, at a reasonable profit to the petitioners. The paternal government lent its official ear kindly to the prayer of the petitioners and with many legal phrases like whereas and be it enacted, etc., had a statute, or a mandamus or an injunction, or whatever it is they call those things, entered upon the minutes to the effect that on and after a certain date, duly specified by the day, the month and the year of our Lord, contracted to A. D., and also the year of the reign of the aforesaid gracious sovereign, duly spelled out, a certain ad valorem duty would be collected by the duly authorized agents of the government on every ton or fractional part thereof of pig iron imported into the commonwealth. Furthermore, the government stood pledged to pay a bounty of $5 a ton on every ton or fractional part thereof of pig iron produced by any of its loyal and patriotic citizens in a domestic hearth, stack, or other suitable device constructed for the reduction of metallic iron from the ore, provided this device was erected on property within the bounds of the commonwealth, and the ore used was mined, quarried, blasted, dug or otherwise exhumed from land within its borders.

"Heartened and encouraged by this kindly, spontaneous and totally unsolicited action on the part of the political party then in power, and viewing with supreme contempt the dastardly and unpatriotic actions of the opposition in their attempts to strangle an infant industry and impede the march of progress and civilization—for as everyone knows, iron is the barometer of trade and the base of all commercial and industrial great-



THE MEMBERS OF THE OLD GUARD HAVE CAUSE TO BE SKEPTICAL

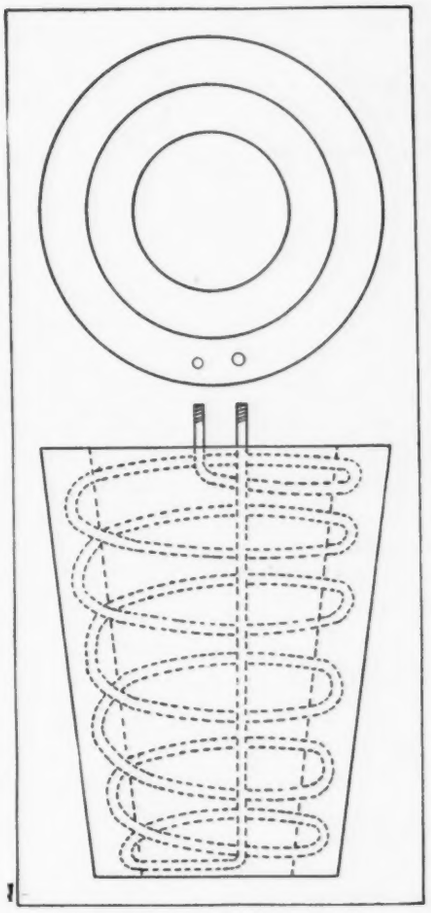
ness, the company proceeded to erect a blast furnace on a site which had been thoughtfully bonded some time before with a view of some such contingency arising. The mineral rights to a certain lot, piece or parcel of land also had been filed in the government archives.

"This was merely a precautionary measure taken to head off and checkmate the possible designs of any piratically minded people, who, when they heard of the industrial expansion about to be inaugurated, might have bonded the property and charged the party of the first part an exorbitant royalty on any minerals taken out, to the detriment of industry and to financial discomfiture of the aforesaid party of the first part.

"Having arranged all these preliminaries as became captains of industry, a blast furnace with all the necessary equipment, including a battery of coke ovens, was rushed to completion. The great day for blowing in at length arrived and the president's daughter, becomingly attired in a marvelous creation made for the occasion, stepped daintily forward and applied the torch.

"It was a great day, and as the local paper pointed out, inaugurated a new era of industry and ere long the stream which crept through the peaceful valley would reflect the lights from a hundred such furnaces and steel plants where as a natural consequence the town would proudly take its place with Sheffield, Pittsburgh and other great iron and steel producing centers of the world.

"Like many similar prophesies, this one was never realized. Owing to economic and political reasons, the company after a few years had elapsed erected a blast furnace and open-hearth plant close to a coal property which had been acquired. The original blast furnace was dismantled and moved to the new site. However what I started to tell you about occurred while the blast furnace still



THE COOLER FOR THE TUYERE OPENING IN A BLAST FURNACE IS PROVIDED WITH A COIL OF PIPE CAST IN

was in active operation in the embryo Pittsburgh.

"As I said, we supplied nearly all the castings for the steel company and naturally after the furnace had been in blast for some time, we were called upon to make repair parts for items which had been burned or worn out. We had opportunity to make castings for practically everything around her, from the charging bell and hopper at the top of the stack to the blow pipes and cinder notch at the bottom. Being a strictly jobbing shop, everything was fish that came to our net and no particular difficulty was experienced in producing any of the castings required. The gaffer was a wise old bird even if he did wear side whiskers, supplemented on Sunday by a high hat. Of course, I am perfectly willing to admit that wearing a silk hat is not a crime and I will even go further and admit that I have seen men who looked good in them; a molder! Oh boy!

"The only casting with which we had any trouble was that known as a *cooler*. You know what it is and for what it is used. It extends through the jacket and hearth wall of the furnace and forms a protection for the blow pipe and the tuyere. The number required of course depends on the size of the furnace. The size and general design of these castings also vary to some extent, but the main features are alike in them all. This old time cooler was about 2 feet long by 15 inches across the wide end, having a 4-inch thickness of metal and carrying a coil of 1-inch wrought-iron pipe, cast in.

"Molding the job was a simple operation, but when the old boy thought about casting it he was afflicted with the oldest disease known to man—cold feet. He never had had any experience with a casting of this particular character and consequently had no definite ideas of just what precautions would be necessary. The more he thought about it the more certain it seemed to him that the molten iron going into the mold would melt the thin wrought iron pipe and fill the coil with iron. If he had just gone ahead and treated the job as an ordinary part of the day's work, a course to which he was tempted by foundry tradition and training, all would have been well. Instead of that he was foolish enough to consult the foreman of the machine shop, who was the particular bright star in this plant. You know, one of those birds who knows everything.

"This lad solved the problem offhand Told the old man all he had to do was to run a stream of water through the coil while the metal was in a liquid state. Now of course the idea was all right, but like lots of other perfectly good ideas, it depended for its usefulness on being applied according to proper engineering principles. One important point which was overlooked in fitting up the water connection was that well known little law of physics which decrees that water expands when exposed to the action of heat, and when heated to a certain temperature is con-

(*Concluded on page* 419)

WHEN BILL HAS MONEY HE IS IN A HURRY AND HAS NO USE FOR THAT PUSSY-FOOT STUFF

THE FOUNDRY

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Foundry Iron Shows Loss

PIG iron production for 1919 showed a marked decrease over that for the previous year. The total as reported by the American Iron and Steel institute was 31,015,364 tons or 20.58 per cent less than the 1919 total of 39,054,644 tons. The causes for this decrease in output are not remote to seek. Industrial disturbances and transportation difficulties took heavy toll. While the industries consuming pig iron did not get their stride until late in the year, the production may be said to be only a little short of consumption. Foundry iron and ferrosilicon which are classified together showed a loss of only 4.44 per cent with a 1919 total of 4,916,758 tons as compared with 5,145,260 tons for 1918. The loss in this case is directly chargeable to causes other than slack demand, for the foundry industry led off early in the summer of 1919 and before the first of the year recorded the greatest volume of business ever encountered in castings manufacture. At the beginning of this activity some blast furnaces making basic iron were converted to the manufacture of foundry grades, and although they again reverted to basic with the increase in demand for the latter product, the effect of the temporary change is evident in the total of foundry iron. Malleable pig iron showed a total 9.74 per cent less for 1919 than for 1918. The totals listed are 1,009,049 tons for last year as compared to 1,117,914 for the previous period. Malleable foundries, in general, did not get into heavy production as early as did the gray iron shops, but the use of malleable grades in foundries making automobile parts in a measure served to sustain the demand for this class of iron during the past year.

Slight Deviations Govern

FREQUENTLY when a foundry process is described some foundryman rises to remark that the thing cannot be done, because he has tried it in an identical manner and has failed. He may be right. His experience is to be trusted, if every minute detail in the method outlined, corresponds accurately with that which he tried. In foundry operations there are so many variables that one slight difference may determine the dividing line between success and failure. A striking example of the influence of minute details upon foundry procedure is illustrated in one instance by the variation in practice followed in adding manganese to iron. One melter adds it in the cupola while another insists that better results are secured when the manganese is added to the metal in the ladle. Both may be correct from their experience. The melter who secures the best results by placing the manganese in the ladle may have an oxidizing atmosphere in his cupola and burn out a large percentage of the manganese when he tries to add it in the cupola. A third melter may say that he secures no appreciable benefit by adding manganese to the iron *either* in the cupola or in the ladle. He, too, may be correct because he may melt an iron which has a low percentage of sulphur and a high percentage of silicon, or he may make castings which are not sensitive to slight changes in the metal. In either case the manganese effect would be minimized to a certain extent and any benefit secured might not be noticed.

Trade Outlook in the Foundry Industry

GLOOMY prospects confront foundries throughout the east and central west. The switchmen's strike, which seemed to be weakening two weeks ago is continuing to restrict shipments both of raw materials and finished products. Some plants are faced by the prospect of early discontinuance through lack of iron; others are out of sand; finished castings which cannot be shipped and paid for are piled in every available space in other foundries; and many have only a day-to-day supply of coke. Varied are the ways in which the transportation tieup operates, but the effect is the same, and unless early relief is effected, the greater portion of the castings industry will suffer severely.

East Is Hard Hit

In New England, the Delaware & Hudson railway affords the only channel for incoming freight, and this road recently has placed an embargo against the New York, New Haven & Hartford. The latter road will receive no pig iron at junction points outside of New ngland for delivery within the district. Providence foundries are consigning shipments to Worcester, Mass., and then reconsigning them to destination. Connecticut foundries are hard hit and several, including the W. & B. Douglas Co., Middletown, one of the oldest in the state, have been forced to close. The main trouble in New England is traceable to traffic congestion and embargoes rather than labor trouble in local yards. It is stated that if the present railway situation continues for two weeks more, fully 20 per cent of the New England foundries will be forced to close. While transportation of some classes of freight is improving through New York and New Jersey, but little pig iron is being received, and a serious shortage is imminent among foundries.

Prices of Raw Materials for Foundry Use

CORRECTED TO MAY 7

Iron		Scrap	
No. 2 Foundry, Valley	$43.25 to 44.25	Heavy melting steel, Valley	$25.25 to 25.50
No. 2 Southern, Birmingham	40.00 to 42.00	Heavy melting steel, Pittsburgh	25.00 to 26.00
No. 2 Foundry, Chicago	43.00 to 45.00	Heavy melting steel, Chicago	23.50 to 24.00
No. 2 Foundry, Philadelphia	45.60 to 46.10	Stove plate, Chicago	33.00 to 33.50
Basic, Valley	43.00 to 43.50	No. 1 cast, Chicago	42.50 to 43.00
Malleable, Chicago	43.50	No. 1 cast, Philadelphia	38.00 to 40.00
Malleable, Buffalo	46.25	No. 1 cast, Birmingham	30.00 to 31.00
Coke		Car wheels, iron, Pittsburgh	39.00 to 40.00
Connellsville foundry coke	12.00	Car wheels, iron, Chicago	38.50 to 39.00
Wise county foundry coke	12.00 to 12.50	Railroad malleable, Chicago	30.00 to 30.50
		Agricultural malleable, Chicago	30.00 to 30.50

Mid-west Is Cut Off

All the great industrial section bounded by Pittsburgh, Cincinnati, St. Louis, Chicago, Detroit, and Buffalo is confronted by the danger of complete stagnation. The shortage of all raw materials is prevalent, but the greatest difficulty is experienced in maintaining sufficient coke. The Pennsylvania and the Baltimore & Ohio railroads are moving solid trainloads of coke out of the Connellsville region, and in cases where these full trains can be moved through to destination without intermediate switching, ample supplies may be had. A number of the larger interests in the vicinity of Pittsburgh have been obliged to curtail production and a few have closed. An instance of the uncertainty prevailing is found in Cleveland, where several large jobbing foundries have closed down for a day or two at a time, resumed operations when needed materials were received and then been obliged to cut down to 50 or 60 per cent of normal activity to conserve supplies. Iron scarcity is being felt more severely through Indiana and Illinois, while in St. Louis supplies of iron which have been enroute from Birmingham for weeks have not been received. The scarcity of iron which can be delivered from Chicago is shown by a recent sale of some 500 tons of malleable by an Ohio furnace company to a Wisconsin melter at $46.50 furnace or about $50 delivered. Chicago and northern Indiana furnaces are piling iron. The effects of the strike seem to be almost entirely confined to those industrial sections where keen labor competition exists. In the south and southwest freight movements are free, despite the shortage of cars.

Iron Little Affected

Production of pig iron was but little affected during April according to statistics gathered by *The Iron Trade Review*. Although the railway strike produced a sudden cessation at the start, resumption gradually was noted during the last week of the month. About 40 blast furnaces were forced out of blast and a great number reduced operations, but the April output showed a decrease of only 623,454 tons as compared with March. The April total was 2,752,314, of which 757,227 tons was merchant iron. The merchant iron loss was 105,940 tons, or 9.38 per cent figured on the daily average. The percentage loss shown in the total iron production was 15.8 per cent. It is probable with the continued obstacles encountered early in May, that the present month will show a greater loss in pig iron production. It is stated that southern iron producers have sold practically all their spot iron for the first half of the year and probably half of their average third-quarter output. Southern foundries are flooded with orders, and in some cases are turning away business. The eastern cast-iron pipe shops have been hampered and in some cases have resorted to 4-day operation, although in the past week relief has been obtained. Pipe demand is strengthening in all sections. However, the southern pipe shops are working to capacity. Some inquiry is reported from Cuban interests for sugar mill machinery castings. Southern foundries are taking some of this work. Automobile requirements still are heavy and largely unsatisfied, due to transportation difficulties. Railroads still are inactive in seeking new equipment, but a fair volume of repair business is being placed. Brass and aluminum foundries report a continued strong demand. Prices of nonferrous metals, based on New York quotations, follow: Copper, 18.50c; lead, 8.62½c to 8.75c; tin, 57.00c to 57.50c; antimony, 9.87½c; aluminum, No. 12 alloy, producers' price, 31.50c and open market, 31.00c. Zinc is quoted at 18.37½c to 18.50c, St. Louis.

Comings and Goings of Foundrymen

FREDERICK G. COTTRELL has been nominated by President Wilson to succeed Dr. Van H. Manning as director of the bureau of mines. Dr. Cottrell was born in Oakland, Calif., Jan. 10, 1877. He was graduated from the University of California in 1896 and taught chemistry in the Oakland high school until 1900, when he went abroad and studied at the University of Berlin and the University of Leipzig, receiving degrees from the latter institution. Returning to this country, he was assistant professor in physical chemistry at his own university until 1911. During this time he evolved the Cottrell process of electrical precipitation of fumes and fine particles suspended in the gases of smelter, blast furnace and cement works. In 1911, when Dr. J. A. Holmes, the first director of the bureau of mines was appointed to study the question of smoke damage from smelters, Dr. Cottrell was appointed chief physical chemist of the bureau. In 1914 he became chief chemist, in 1916 chief metallurgist and in 1919, assistant director. Dr. Van H. Manning, who has tendered his resignation as director, effective June 1, is leaving the government service to become director of research with the recently organized American Petroleum institute. Dr. Manning has been in active service with the department of the interior for the past 34 years.

G. Johnson, who formerly was with the Wellman-Seaver-Morgan Co., Akron, O., has been made foundry superintendent for the Minerva Engine Co., Cleveland.

George N. Jeppson, secretary and works manager of the Norton Co., Worcester, Mass., will sail for Europe May 15, combining business with pleasure.

George A. Laub, formerly with the American Car & Foundry Co., has become superintendent of the plant of the Sligo Iron & Steel Co., Connellsville, Pa.

P. A. Gaynor, formerly manager of service and sales for the Bryan Pattern & Machine Co., Bryan, O., has assumed similar duties with the Non-Ferro Foundry & Pattern Co., 1361 West Bancroft street, Toledo, O.

Fred T. Moran, Detroit stove manufacturer, has been elected a director of the Charcoal Iron Co. of America, succeeding George J. Webster, of Marquette, Mich., retired. Other directors were re-elected.

Frank E. Lampson, who for many years has been in charge of the shipping and receiving departments of the Sessions Foundry Co., Bristol, Conn., has been made an assistant to President William E. Sessions.

Bushnell Bigelow, formerly eastern manager of sales for the New Jersey Zinc Co., New York, has been appointed assistant general sales manager of that company. Walter I. Hess succeeds Mr. Bigelow as manager of eastern sales.

R. W. Gallager, assistant general manager of the East Ohio Gas Co., Cleveland, will resign June 1 to become acting president of the Motor Castings Co., Canton, O. The Canton plant manufactures motors for trucks and tractors.

Charles H. Noble, president of the Vi Brass & Aluminum Co., Massillon, O., died recently at the age of 60 years. Mr. Noble who was a resident of Lima, O., was engaged in the work of establishing the Massillon foundry at the time of his death.

K. M. Glass and J. A. Arthur recently have incorporated the Glass-Arthur Iron & Brass Foundry and have started operations in Gastonia, N. C. Mr. Glass formerly was connected with Bartlett & Haywood, Baltimore, while Mr. Arthur until recently was foreman of the Moffet Machine Co., Charlotte, N. C.

Boetius H. Sullivan was elected chairman of the board of directors at a recent meeting of the Independent Pneumatic Co., Chicago. The other officers chosen were John D. Hurley, president; Ralph S. Cooper, first vice president; Fletcher W. Buchanan, secretary, and Edward G. Gustafson, treasurer.

A. Leon Scott has been made sales manager for the Arcade Malleable Iron Co., Worcester, Mass. Until recently Mr. Scott was sales agent of the Naugatuck works of the Eastern Malleable Iron Co. and during his affiliation with that organization he received a varied and world-wide experience in marketing castings.

A. M. Fulton, for the past 13 years with the Fort Pitt Malleable Iron Co., Pittsburgh, resigned on May 1. Mr. Fulton served the company in various capacities and for the last three years has been general superintendent. He has always taken a general interest in foundry association affairs and now is president of the Pittsburgh Foundrymen's association.

A. B. Van Eschen, formerly works manager, Michigan Steel Casting Co., Detroit, has formed a syndicate which has purchased the Monroe Steel Casting Co., Monroe, Mich. The plant is equipped with a one and a half-ton Booth-Hall and a one-ton Snyder electric furnace. The new interests will thoroughly modernize the property, installing the necessary equipment to put it on a high production basis. C. F. Clark, formerly treasurer of the Steel Products Co., Detroit and Cleveland, has been elected president.

E. B. Horne recently resigned his position as manager of the forge and foundry divisions of the Packard Motor Car Co., Detroit. Mr. Horne had been with the Packard company for the past 12 years. He intends to devote his attention to personal interests, particularly the Rochester Foundry & Machine Co., Rochester, Mich., of which he is president. This company now is engaged in the production of iron, brass and aluminum castings and patterns. The addition of a malleable department is contemplated.

Harry Carson has resigned his connection with Rogers, Brown & Co., to organize Carson & Co., with headquarters in the Pennsylvania building, Philadelphia. Carson & Co. will conduct a general brokerage business, handling foundry and steel mill supplies, including pig iron, coke and ferroalloys. Mr. Carson's connection with the Rogers, Brown interests dates back 20 years, first at Buffalo with the Rogers, Brown & Co., and the Rogers-Brown Iron Co., and later at the Philadelphia office of Rogers, Brown & Co.

New York Foundrymen Discuss Costs

In preparation for a joint meeting on May 12 of the Newark Foundrymen's association, in conjunction with the Gray Iron club, New York, the former association sent out a blueprint with the request that all of the members quote their best price per pound, at the foundry. At the meeting the quotations were opened as at a public letting and the various bidders were asked to justify their quotations explaining how they are made up.

The Newark Foundrymen's asso-

ciation now is quoting from its members' information with respect to their yearly consumption of pig iron, the districts from which the pig iron is obtained, present freight rates, and present means of unloading and receiving the pig iron. This information is desired so that the proposed increase of freight rates to Newark can be taken up with the newly-formed traffic section of the board of trade of Newark.

Bill Comments on Blast Furnace Coolers

(*Concluded from page* 415)

verted into steam. It also is a matter of common knowledge that steam occupies an immense space compared to the volume of water from which it was derived. You probably have found out those things for yourself tonight so I will not dwell any longer on that point.

"When the mold was ready for the iron, a length of hose was connected to a tap on the city water supply and the other end was slipped over the end of one of the protruding pipes in the mold. Another short piece of hose was attached to the second pipe, the free end of the hose being led into the water barrel to receive the overflow. The ladle of iron was swung around on the crane and most of the men in the shop crowded up to watch the performance. When the mold was about one-quarter full the steam pressure jerked the hose loose from the water tap and you can imagine what happened after that. The two pieces of hose jumped and flew around as if they were alive, squirting steam and boiling water at every jump. The shop was low and dark and full of steam and the gang just trusted to instinct and broke away in all directions. A few managed to reach the door; some jumped out through the windows; others landed in the core oven; one innocent young man who had left the farm and came to the town to make his fortune got such a fright that he never came back even for his back time. After the excitement died down, I found myself in the bottom of the coal box behind the stove with a big hairy molder on top of me.

"The next day the old man threw the hose out the window. We made another mold, gated it tangentially near the bottom, poured the metal a little on the dull side and there was no more excitement about it than there would be about pouring a button for the back door. We made several after that, but never tried to water cool any of them with a piece of hose loosely connected to the water tap.

"As I said before, the idea is all right. I saw it adopted many years afterward in casting steel rams for open-hearth charging machines. Considerable trouble had been experienced in cleaning the cores out of these castings so it was decided to use an extra heavy 4-inch steel tube for a core. The tube was made long enough to extend through both ends of the flask; it was threaded at both ends and suitable connections for 1-inch pipes attached. The water was turned on about a minute before commencing to pour the steel and left running until the casting was set. When cleaning the casting the tube was cut off flush at both ends leaving a perfect hole which required no cleaning."

"All right," I said, "let's forget that work stuff for a while. If you wait a few minutes until I wash my face and hands. I'll try to borrow 15 cents and shoot you a game of pool."

"Forget it," said he, "I've got a quarter, come on." It was not until he had trimmed me four times in succession that I got the full import of the words "come on."

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The F. & H. Foundry Co., Newark, N. J., is having plans drawn for the erection of a plant.

The Mt. Carmel Brass Co., Hamden, Conn., plans the erection of a plant addition.

The core room and foundry of the Vulcan Plow Co., Evansville, Ind., recently was damaged by fire.

Erection of a foundry, 60 x 100 feet, is planned by the Walker Machine & Foundry Co., Roanoke, Va.

The plant of the Mahanoy City Foundry & Machine Co., Mahanoy, Pa., recently was damaged by fire.

Balke & Co., iron founders, Louisville, Ky., have increased their capital from $25,000 to $50,000.

The Ashland Foundry & Machine Shops, Ashland, Ky., recently were damaged by fire.

The Bay View Foundry Co., Sandusky, O., has increased its capital from $200,000 to $300,000.

The plant of the Schultheiss Mfg. Co., Los Angeles, has been acquired by the Hercules Foundry Co.

The foundry of the Gross Mfg. Co., Hazelton, Pa., recently was damaged by fire.

Extensions to its plant are being planned by the C. E. Davis Foundry Co., Rutland, Vt.

The Elliot Foundry Co., 139 North Clark street, Chicago, contemplates the erection of a foundry.

The Harrison Safety Boiler Works, Norristown, Pa., contemplates the erection of an addition to its foundry, 25 x 48 feet.

A foundry, 16 x 200 feet, is planned by the American Radiator Co., 1807 Elmwood avenue, Buffalo.

The Eastern Malleable Iron Co., 719 South avenue, Bridgeport, Conn., has plans for the erection of a foundry, 68 x 179 feet.

The Akron Brass Mfg. Co., Wooster, O., plans the erection of a shop building, one story, 40 x 185 feet.

The Hudson Brass Works, 16 Nassau street, Brooklyn, N. Y., has awarded a contract for the erection of a plant, 100 x 300 feet.

The capital stock of the Terre Haute Malleable & Mfg. Co., Terre Haute, Ind., has been increased from $100,000 to $1,000,000.

The Chicago Faucet Co., 2716 Crawford avenue, Chicago, has let a contract for the erection of an addition to its foundry, 54 x 100 feet.

The Oregon Foundry Co., Portland, Ore., recently was incorporated with a capital of $15,000, by H. E. Harris, Milton B. Henderson and others.

Plans have been prepared for the erection of a 2-story addition to the plant of the Stroh Castings Co., Detroit.

The capital stock of the Maumee Pattern Co., Toledo, O., recently was increased from $10,000 to $100,000.

John N. Miller, 145 Gertrude court, Pasadena, Cal., and others, have organized the Pasadena Foundry Co.

Plans have been prepared for the erection of an addition to the plant of the Standard Brass Casting Co., Oakland, Cal.

Plans are being prepared for the erection of a foundry, 70 x 120 feet, by the Union Railroad Equipment Co., 332 South Michigan avenue, Chicago.

Plans are being prepared for the erection of a building, 25 x 30 feet, for the Keeley Stove Co., Columbia, Pa.

The Beaver Valley Alloy Foundry Co., Rochester, Pa., has been incorporated with a capital of $30,000, by Charles E. Coleman and others.

Erection of an addition to its plant, one story, 30 x 75 feet, is contemplated by the Henry Poppert Pattern & Mfg. Co., 505 Cedar street, Milwaukee.

The capital stock of the Pitz & Weber Iron Foundry, New York, has been increased from $150,000 to $250,000.

The capital stock of the Liberty Foundry Co., Detroit, recently was increased from $25,000 to $100,000.

The chamber of commerce of Richmond, Mich., has arranged for the establishment of a foundry, on a 10-acre site, which will employ about 200 men.

The Monarch Brass Works, Louisville, Ky., has been incorporated with a capital of $20,000, by Charles F. Grainger and others.

The Bay City Foundry & Machine Co., Bay City, Mich., whose foundry recently was damaged by fire, plans to rebuild immediately.

Capitalized at $50,000, the Barberton Foundry Co., Akron, O., has been incorporated by J. A. Lanigan, A. F. O'Neil and others.

The Independent Foundry & Machine Co., Punxsutawney, Pa., recently was incorporated with a capi-

tal of $25,000, by G. Frank Porter and others.

The Lukenheimer Co., Carthage, O., has plans for the erection of an addition to its foundry, 230 x 301 feet.

The A. J. Detlaff Co., 121 Lafayette avenue, Detroit, plans the erection of an addition to its foundry, 51 x 87 feet.

A foundry and machine shop is being planned for the Richmond Foundry & Machine Co., Richmond, Mich.

Erection of an addition to its core room, two stories, 72 x 100 feet, is being planned by the Odin Stove Mfg. Co., Erie, Pa.

The Loomis Selaff Co., 6616 Morgan avenue, Cleveland, has plans for the erection of a foundry, 60 x 120 feet.

The McFarland Foundry & Machine Co., Trenton, N. J., plans the erection of a foundry building, 50 x 120 feet.

The Buckeye Steel Castings Co., Columbus, O., recently increased its capital from $2,500,000 to $4,500,000.

Erection of an addition to its foundry is being planned by the Pratt Chuck Co., 43 Cedar street, Oneida, N. Y.

The Mack Mfg. Co., Houston, Tex., contemplates the erection of an addition to its plant, which will include a foundry.

Capitalized at $60,000, the Ornamental Foundry Co., Anniston, Ala., recently was incorporated by C. A. Hamilton and others.

The Wood-Embly Brass Co., Rouzerville, Pa., plans to rebuild its plant which recently was damaged by fire.

The J. W. Richardson Foundry & Metals Corp., Brooklyn, N. Y., recently increased its capital from $15,000 to $30,000.

The Sterling Die Casting Co., Brooklyn, N. Y., recently increased its capital from $120,000 to $180,000.

B. F. Avery & Sons, Inc., Louisville, Ky., recently increased its capital to finance the erection of an addition to its plant.

The Kentucky Wagon Mfg. Co., Louisville, Ky., has purchased eight acres on which it plans to build additional foundry and machine shops.

The Hampden Brass Co., Springfield, Mass., has let a contract for the erection of an addition to its foundry, 32 x 50 feet.

Capitalized at $50,000, the Hatboro Foundry Co., Hatboro, Pa., recently was incorporated by William W. Wilgus, Albert E. Koch, Kenkintown, Pa., and Melvin W. Stryker.

The J. F. Tice Co., Lagrange, Ga., which was recently incorporated with a capital of $25,000, will engage in the manufacture of castings. J. F. Tice is president of the company.

Plans are being prepared for the erection of an addition to the plant of the Anderson Foundry & Machine Works, Anderson, Ind. The building will be 130 x 220 feet.

Cohen-Radow, iron foundry, Brooklyn, N. Y., recently was incorporated with a capital of $10,000, by S. and I. Cohen, and B. Radow, 1150 President street.

Work has been started by the Galt Brass Co., Galt, Ont., on the erection of two plant additions. The foundry will be 60 x 140 feet and the other structure 40 x 50 feet.

Capitalized at $400,000, the Ontario Foundry Co., Ltd., Toronto, Ont., recently was incorporated by Peter Kirkegaard, Wilfred W. Parry, Horace B. Proudlove and others.

The Western Reserve Foundry Co., Cleveland, recently was incorporated with a capital of $50,000, by A. F. Gaughan, R. E. Collins, Williamson building, and others.

The Des Moines Foundry & Machine Co., Des Moines, Iowa, plans the erection of a foundry and machine shop. C. N. Schmitt, 314 Flynn building, is manager of the company.

The Detroit Ring Casting Co., Detroit, recently was incorporated with a capital of $125,000, by John Magee and others, to engage in a general foundry business.

The Wabash Valley Mfg. Co., Perryville, Ind., recently was incorporated with a capital of $5000 to conduct a general foundry business, by Charles H. Cochran, Emil R. Jahna and Paul J. Hawkins.

The Illinois Malleable Iron Co., Chicago, has a permit to erect a plant building.

A site has been purchased by the Bernert Mfg. Co., 489 Twelfth street, Milwaukee, on which it plans the erection of a plant, 120 x 260 feet, which will include a foundry and machine shop.

Capitalized at $75,000, the Aetna Brass Mfg. Co. recently was incorporated by E. H. Krueger, Illuminating building, Cleveland, E. B. Carbaugh, C. G. Townes, B. Comstock and others.

Architect Z. E. Smith, 305 East Fifty-fifth street, Chicago, is preparing plans for the erection of a foundry and machine shop, 50 x 100 feet, for the Duvoal Ingraham Steel Co.

The Seville Foundry & Machine Co., Seville, O., recently was incorporated with a capital of $60,000, by J. R. Minton, H. J. Freeman, C. V. Matteson, N. L. Williamson, J. C. Murray, O. Smith and F. C. Bauer.

The Loeffler Machine Co., Sheboygan, Wis., capitalized at $100,000, has been chartered to take over the business of William Loeffler Machine Co., and will erect a gray iron foundry, 80 x 132 feet, and a machine shop addition, 40 x 100 feet.

The West Bridgewater Foundry, West Bridgewater, Mass., recently was incorporated with a capital of $10,000, by Cecil E. Whitney, Newton, Mass., Abram Berkowitz, Boston, and John F. Rollins, Cambridge, Mass.

The Blackhawk Foundry & Machine Co., Davenport, Iowa, recently was incorporated with a capital of $80,000, to conduct a general foundry and machine shop, by Walter K. Voss, Howard W. Power, Henry W. Hubes and Harry F. R. Voss.

The Gunning Iron & Brass Foundry, Inc., New Bedford, Mass., recently was incorporated to operate a foundry and machine shop, with a capital of $50,000, by Andrew Gunning, John B. Lowney, H. L. Potter, George R. Dahn and others.

To care for the expansion in its business and to operate an additional foundry at Toledo, O., the Detroit Stoker Co., Detroit, recently increased its capital to $200,000. For the present equipment requirements have been taken care of.

Capitalized at $200,000, the Elizabeth Foundry Co., Newark, N. J., recently was incorporated by George W. Potter, Gustave Haussling and Alfred W. Cooper.

Extensions are being made to its steel foundry by the National Brake & Electric Co., Milwaukee, for increasing its molding floor space. It also is adding another 15 to 20-ton tilting open-hearth furnace to its equipment.

Improvements made possible by an increase in capital stock will practically double the capacity of the Marysville, O., plant of the Regent Brass Foundry Co., 326 Lakeside avenue, Cleveland. Sidney L. Fisher is vice president of the company.

Instead of erecting a new plant, consisting of foundry and machine shops, the Milwaukee Ice Machine Co., 1001 Cold Spring avenue, Milwaukee, has purchased the plant of the Steam Appliance Co., West Allis, Wis., and has abandoned its original construction plans.

The American Furnace & Foundry Co., Milan, Mich., recently was organized with a capital of $100,000, to manufacture furnaces. The company will erect a plant, 80 x 250 feet, the contract for which has been let. Officials are: President, E. L. Watson; vice president, E. D. Minzey; general manager, F. E. Fulkerson, and secretary and treasurer, F. E. Ross. It is expected the company's plant will be ready for operation about Aug. 1.

Molding machines, screw machines, milling machines, air compressors, etc., are needed by the Regle Brass Co., Greenville, Mich., which recently completed the erection of a plant, 60 x 200 feet. The plant is equipped with 10 brass furnaces nickel plating, polishing, machine and tool rooms. For the present the company's efforts will be confined to the manufacture of plumbers' brass. The company, which is capitalized at $100,000, expects to be in a position to start marketing its products by July 1.

New Trade Publications

HOISTS.—Electric hoists, chain blocks, cranes and trolleys are described and illustrated in a small booklet recently published by the Franklin Moore Co., Winsted, Conn. Specifications are given.

INDUSTRIAL TRUCKS.—An illustrated folder has been prepared by the Clark Tructractor Co., Chicago, showing industrial trucks which it manufactures, at work, and the various types which are adapted to different work.

FLEXIBLE ARM.—The Breeze Mfg. Co., Newark, N. J., has issued a folder in which a flexible metal arm for electric light fixtures is described and illustrated. This arm according to the folder, directs the light 100 per cent to the spot where it is required. Construction details and other data are given.

FLEXIBLE TUBING.—The Breeze Mfg. Co., Newark, N. J., has prepared a 36-page booklet in which flexible metal hose, tubing and accessories are described and illustrated. General data are given concerning the various uses of this material, and the technical information should be of value to engineers.

ELECTRIC HOISTS.—A booklet has been published by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., in which electric hoists are described and illustrated. The illustrations show the various work to which these hoists can be put, and installations ranging from the transportation of soup to the assembling of motor cars are shown.

HAMMERS.—The David Maydole Hammer Co., Norwich, N. Y., has published two booklets in which hammers which it manufactures are described and illustrated. One booklet is a pocket catalog, and besides containing information concerning the hammers, contains a story of the life of David Maydole, a number of interesting tables, and general information useful to mechanics, etc. The second booklet contains detailed information and specifications of the hammers.

FRICTION CLUTCHES.—A booklet has been published by the Carlyle Johnson Machine Co., Manchester, Conn., in which the achievements of friction clutches in the field of machine designing are outlined. Applications of friction clutches to the various machine tools are illustrated and described in detail, showing the flexibility of design. Other details of interest are given.

METALLIC TUBING.—The Pennsylvania Flexible Metallic Tubing Co., Philadelphia, has published a booklet in which flexible metal hose is described and illustrated. This tubing consists of a continuous bronze or steel tape, rolled in a spiral, so that the edges interlock, forming a 4-wall construction. As the tape is rolled a groove is formed, which contains an asbestos packing to protect the tubing from wear. Other details are given, as well as the various purposes for which this tubing is adapted.

SOLDERING IRONS.—Electric soldering irons are described in a 4-page leaflet recently published by the Cutler-Hammer Mfg. Co., Milwaukee. In addition to the irons, associated equipment, including automatic racks, soldering fixtures and current regulators for current control are described in the leaflet. Mention is made of the sealed core of the soldering iron, which according to the leaflet, is impervious to heated acid, solder or moisture. A renewable copper tip screws over the heater core, where the heat is concentrated. The leaflet besides giving details as to the equipment, lists five different sizes of irons, enumerating the kind of work to which each size is adapted.